

DATA SENTRY 10 DATA COMMUNICATIONS ANALYZER OPERATING MANUAL

This manual applies to DATA SENTRY 10
Data Communications Analyzers with configuration
level identifiers ending with the letter "C"

CAUTIONS AND WARNINGS

CAUTION

Cautions are used throughout this manual to highlight procedures or actions which may result in damage to equipment.

////////////////////////////////////

WARNING

Warnings are used throughout this manual to highlight procedures or actions which may be hazardous to personnel.

////////////////////////////////////

FAILURE TO OBSERVE CAUTIONS AND WARNINGS MAY RESULT IN EQUIPMENT DAMAGE OR PERSONAL INJURY.



Digitized by the Internet Archive
in 2026

https://archive.org/details/manualsplus_13439

MANUAL ABSTRACT

This operating Manual comprises 12 sections and several appendices. Each manual section is briefly described below.

Section 1 GENERAL INFORMATION

This section contains a general description of the DATA SENTRY 10, lists the standard equipment supplied with the instrument, and describes the options and accessories available.

Section 2 SPECIFICATIONS

The capabilities of the DATA SENTRY 10, its measurement accuracies, and its requirements are specified in this section.

Section 3 PREPARATION FOR USE

This section contains unpacking and inspection instructions, power requirements, and installation instructions.

Section 4 FUNCTIONAL DESCRIPTION

The measurement capabilities of the DATA SENTRY 10 are detailed in this section, and definitions are given for test and measurement parameters. All of the front and rear panel controls and indicators are described in this section.

Section 5 OPERATING INSTRUCTIONS AND APPLICATIONS INFORMATION

This section contains step-by-step setup and operating sequences, taking the user from power-up to system test. The choice of operating modes and test parameters is discussed, and descriptions of how to use the DATA SENTRY 10 in various situations and how to analyze test results are provided.

Section 6 INSTRUMENT CHECKOUT

The automatic self-test routines of the DATA SENTRY 10 are described in this section, and procedures for manually checking the operation of the instrument are given.

Section 7 PRINTER/REMOTE CONTROL INTERFACES

In this section, the printer data formats, printer events and the printer control mechanisms are described. Use of the remote control ports, and operation of the DATA SENTRY 10 via remote control are detailed in this section.

Section 8 DATA INTERFACES

The electrical characteristics of the various data interfaces and interconnection information are presented in this section.

Section 9 PRINTER

The use of and the maintenance of the optional internal printer are described in this section.

Section 10 VOICE FREQUENCY MEASUREMENT MODULE

This section provides operating instructions and specifications for the optional Voice Frequency Measurement Module. The measurement capabilities of the module and the remote control command formats are discussed.

Section 11 OPTIONS AND ACCESSORIES

Options and accessories available for use with the DATA SENTRY 10 are described.

Section 12 MAINTENANCE AND SERVICE

Warranty, servicing and shipping information are provided in this section.

TABLE OF CONTENTS

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
1.0	GENERAL INFORMATION	1-1
1.1	Introduction	1-1
1.2	Manual And Instrument Identification	1-1
1.3	Instrument Description	1-1
1.4	Equipment Supplied	1-2
1.5	Options Available	1-3
1.6	Accessories Available	1-3
2.0	SPECIFICATIONS	2-1
2.1	Modes Of Operation	2-1
2.2	Generator	2-1
2.2.1	Generator Timing System	2-1
2.2.2	Data Generator	2-3
2.3	Receiver	2-4
2.3.1	Receiver Timing System	2-4
2.3.2	Data Error Analysis	2-5
2.3.3	Frequency Measurements	2-7
2.3.4	Distortion Measurements	2-7
2.3.5	Delay Measurements	2-8
2.3.6	Data Trapping	2-9
2.4	Voice Frequency Measurement Modules	2-9
2.4.1	Transmitter	2-9
2.4.2	Receiver	2-9
2.5	Programmability	2-10
2.5.1	User Defined Messages	2-10
2.5.2	Front Panel Programs	2-10
2.5.3	Non-Volatile Memory	2-10

TABLE OF CONTENTS (CONTINUED)

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
2.6	Remote Control Capability	2-11
2.7	Data Interfaces	2-11
2.7.1	RS-232C/V.24 Data Interface	2-11
2.7.2	V.35/306 Data Interface	2-12
2.7.3	RS-449/MIL-188-114/MIL-188C Data Interface	2-12
2.8	Rear Panel Connectors And Test Points	2-13
2.8.1	Audio Output Test Points	2-13
2.8.2	X And Y Input Test Points	2-13
2.8.3	Alarm Test Points	2-13
2.8.4	Miscellaneous Test Points	2-14
2.9	Real Time Clock	2-14
2.10	Power Requirements	2-14
2.11	Environmental Specifications	2-15
3.0	PREPARATION FOR USE	3-1
3.1	Introduction	3-1
3.2	Unpacking And Initial Inspection	3-1
3.3	Rack Mounting Instructions	3-1
3.4	Power Requirements	3-1
3.5	Operating Environment	3-2
4.0	FUNCTIONAL DESCRIPTION	4-1
4.1	Introduction	4-1
4.2	Generation Capability	4-1
4.2.1	Fixed Patterns	4-1
4.2.2	Pseudorandom Patterns	4-1
4.2.3	Messages	4-2

TABLE OF CONTENTS (CONTINUED)

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
4.2.4	Character Format	4-3
4.2.5	Preambles	4-3
4.2.6	Data Inversion And Error Insertion	4-4
4.2.7	Signaling Interaction	4-4
4.3	Measurement Capability	4-5
4.3.1	Error Analysis	4-5
4.3.2	Synchronization	4-7
4.3.3	Frequency Measurements	4-8
4.3.4	Distortion Measurements	4-9
4.3.5	Delay Measurements	4-10
4.3.6	Data Trapping	4-11
4.3.7	Real Time Clock	4-11
4.4	Modes Of Operation	4-12
4.4.1	Full Duplex Mode	4-12
4.4.2	Single Transmit Mode	4-12
4.4.3	Half Duplex Operation	4-12
4.4.4	Self Loop Mode	4-14
4.4.5	Synchronous Timing Mode	4-16
4.4.6	Asynchronous Timing Mode	4-16
4.4.7	Recovered Timing Mode	4-18
4.4.8	Emulate DTE And Emulate DCE Modes	4-18
4.4.9	Trap And Analyze Modes	4-18
4.5	Controls, Indicators, Displays, And I/O Description	4-19
4.5.1	Front Panel	4-19
4.5.2	Rear Panel	4-32
4.6	Auxiliary Functions	4-37
4.6.1	Introduction	4-37
4.6.2	Status Select Functions	4-38
4.6.3	Short Data Entry Functions	4-38

TABLE OF CONTENTS (CONTINUED)

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
4.6.4	Long Data Entry Functions	4-45
4.6.5	Special Functions	4-47
4.6.6	VF Measurement Module Selection	4-50
4.6.7	Successive Access Of Auxiliary Functions	4-50
5.0	OPERATING INSTRUCTIONS AND APPLICATIONS INFORMATION	5-1
5.1	Introduction	5-1
5.2	Instrument Setup And Use	5-1
5.2.1	User Interface With The Data Sentry 10	5-1
5.2.2	Switch Contentions	5-1
5.2.3	Functional Division Of The Instrument	5-2
5.2.4	Selection Of Data Interface And Emulation Mode	5-4
5.2.5	Instrument Setup For Error Analysis	5-5
5.2.6	Performing Error Analysis Testing	5-8
5.2.7	Single Transmit Mode	5-15
5.2.8	Frequency, Delay, And Distortion Measurements	5-15
5.2.9	Saving The Instrument Configuration	5-19
5.3	Operating Considerations	5-19
5.3.1	Data Selection	5-19
5.3.2	Reverse Pseudorandom Pattern Capability	5-21
5.3.3	Timing Selection	5-21
5.3.4	Operating Speed Limitations	5-22
5.3.5	BER Interval Selection	5-23
5.3.6	Block Length Selection	5-23
5.3.7	Use Of BER And Receiver Frequency Alarms	5-24
5.3.8	Receiver Configurations	5-24
5.3.9	Interpreting The Seconds Count	5-28
5.3.10	Low Speed Operation	5-28

TABLE OF CONTENTS (CONTINUED)

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
5.3.11	Distortion Measurements	5-29
5.3.12	Frequency Measurements	5-30
5.3.13	Statistical Multiplexer Testing	5-30
5.3.14	Signaling Interaction	5-31
6.0	INSTRUMENT CHECKOUT	6-1
6.1	Introduction	6-1
6.2	Automatic Self Test	6-1
6.3	Manual Self Test	6-1
6.3.1	Equipment Required	6-1
6.3.2	Preparation	6-1
6.3.3	Procedure	6-2
7.0	PRINTER/CONTROLLER INTERFACES	7-1
7.1	Introduction	7-1
7.1.1	Printer Selection	7-1
7.1.2	Controller Selection	7-1
7.2	Printout Formats	7-2
7.2.1	Results Print	7-2
7.2.2	Controls Print	7-3
7.2.3	Miscellaneous Printouts	7-4
7.3	General Controller Commands	7-5
7.3.1	Command Format	7-5
7.3.2	Switch Commands	7-6
7.3.3	Non-Switch Commands	7-9
7.4	RS-232 Printer/Controller Interface	7-13
7.4.1	Switch Settings and Connector Pinouts	7-13

TABLE OF CONTENTS (CONTINUED)

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
7.4.2	Input Sequence	7-13
7.4.3	Output Sequence	7-17
7.4.4	Fault Messages	7-17
7.5	IEEE-488 Remote Control Interface	7-18
7.5.1	Switch Settings and Mode Selection	7-18
7.5.2	IEEE-488 Commands	7-19
7.5.3	Input Sequence	7-19
7.5.4	Output Control	7-22
7.5.5	Output Sequence	7-23
7.5.6	Installation and Removal	7-25
7.6	HP-IL Remote Control Interface	7-26
7.6.1	HP-IL Commands	7-26
7.6.2	Input Sequence	7-26
7.6.3	Output Control	7-31
7.6.4	Output Sequence	7-33
7.6.5	Fault Messages	7-33
7.6.6	Installation and Removal	7-33
8.0	DATA INTERFACES	8-1
8.1	Introduction	8-1
8.2	RS-232-C/V.24 Data Interface	8-3
8.2.1	General	8-3
8.2.2	Functional Description	8-3
8.2.3	Clock-Data Phasing	8-7
8.2.4	Specifications	8-8
8.3	V.35/306 Data Interface	8-9
8.3.1	General	8-9

TABLE OF CONTENTS (CONTINUED)

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
8.3.2	Functional Description	8-9
8.3.3	Clock-Data Phasing	8-11
8.3.4	Specifications	8-12
8.4	RS-449/MIL-188-114/MIL-188C Data Interface	8-15
8.4.1	General	8-15
8.4.2	Modes Of Operation	8-15
8.4.3	Functional Description	8-17
8.4.4	Clock-Data Phasing	8-20
8.4.5	Specifications	8-21
9.0	INTERNAL PRINTER	9-1
9.1	General	9-1
9.2	Paper Loading	9-1
9.3	Maintenance	9-3
9.4	Installation And Removal	9-3
10.0	VOICE FREQUENCY MEASUREMENT MODULE	10-1
10.1	Introduction	10-1
10.2	Functional Description	10-1
10.2.1	Introduction	10-1
10.2.2	The Transmitter	10-1
10.2.3	The Receiver	10-2
10.2.4	The VF And The DATA SENTRY 10	10-2
10.3	Operation	10-4
10.3.1	Introduction	10-4
10.3.2	VF Selection Guide	10-4
10.3.3	Transmitter Operation	10-9

TABLE OF CONTENTS (CONTINUED)

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
10.3.4	Receiver Operation	10-10
10.4	Remote Control	10-11
10.4.1	Introduction	10-11
10.4.2	Command Format	10-11
10.4.3	Examples	10-11
10.5	Specifications	10-13
10.5.1	General	10-13
10.5.2	Transmitter	10-13
10.5.3	Receiver	10-14
10.6	Installation And Self Test	10-17
10.6.1	Installation Procedure	10-17
10.6.2	Removal Procedure	10-17
10.6.3	VF Module Self Test	10-17
11.0	OPTIONS AND ACCESSORIES	11-1
11.1	Introduction	11-1
11.2	Rack Mount Kit (Model 10413)	11-1
11.3	Soft Carrying Case (Model 10412)	11-1
11.4	Hard Shipping Case (Model 10411)	11-2
11.5	High Stability Time Base (Option 10454)	11-2
12.0	MAINTENANCE AND SERVICE	12-1
12.1	In Case Of Difficulty	12-1
12.2	Warranty Policy	12-1
12.3	In-Warranty Service	12-1

TABLE OF CONTENTS (CONTINUED)

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
12.4	Out-Of-Warranty Service	12-2
12.5	Repackaging For Shipment	12-2
APPENDIX A	ABBREVIATIONS	A-1
APPENDIX B	HEX CONVERSION TABLE	B-1
APPENDIX C	TREND 1-9-1 MESSAGES	C-1

LIST OF ILLUSTRATIONS

<u>FIGURE</u>	<u>TITLE</u>	<u>PAGE</u>
4-1	Half Duplex Control Sequence Showing Time Delays	4-15
4-2	Typical DTE To DCE Interface	4-17
4-3	DATA SENTRY 10 Front Panel	4-20
4-4	DATA SENTRY 10 Rear Panel	4-33
8-1	Block Diagram, RS-232-C/V.24 Data Interface	8-4
8-2	Block Diagram, V.35/306 Data Interface	8-10
8-3	Block Diagram, RS-449/MIL-188-114/ MIL-188C Data Interface	8-18
8-4	37-Pin "D" to 25-Pin "D" Male-to-Male Adaptor Cable	8-27
9-1	Internal Printer, Side View	9-2
9-2	Printer Installation, Top View	9-4
10-1	Printouts With VF Measurement Module	10-5
10-2	Auxiliary Function 80 VF Selection Guide	10-6
10-3	Noise Weighting Filters	10-16

LIST OF TABLES

<u>TABLE</u>	<u>TITLE</u>	<u>PAGE</u>
3-1	Fuse Selections	3-2
4-1	BER Display Format	4-5
4-2	Delay Measurement Start And End Signals	4-11
4-3	Status Select Functions	4-39
4-4	Short Data Entry Functions	4-46
4-5	Auxiliary Function 85 Status Choices	4-50
5-1	Full Duplex Error Analysis Results	5-10
5-2	Half Duplex Error Analysis Results	5-11
5-3	BER Display Format	5-23
5-4	Frequency Counter Accuracy	5-31
5-5	Signaling Leads Implemented	5-32
6-1	Manual Self Test Switch Positions	6-2
6-2	Manual Self Test Switch Positions	6-3
6-3	Manual Self Test Switch Positions	6-4
6-4	Manual Self Test Results	6-4
6-5	Manual Self Test Switch Positions	6-5
6-6	Manual Self Test Entry and Display	6-5
6-7	Manual Self Test Switch Positions	6-6
7-1	Automatic Printer Selection	7-2
7-2	Switch And Switch Position Command Mnemonics	7-7

LIST OF TABLES (CONTINUED)

<u>TABLE</u>	<u>TITLE</u>	<u>PAGE</u>
7-3	DISPLAY/ENTRY Switch Mnemonics And Entry Format	7-8
7-4	Non-Switch Commands	7-10
7-5	RS-232 Printer/Controller Interface DIP Switch	7-14
7-6	RS-232 Printer/Controller Interface Pinouts	7-15
7-7	IEEE-488 Command Mode Commands	7-20
7-8	Serial Poll Status Byte	7-24
7-9	Response To HP-IL Commands	7-27
7-10	Status Byte Definition	7-32
8-1	RS-232-C/V.24 Data Interface Connector Pin Assignments	8-5
8-2	V.35/306 Data Interface Connector Pin Assignments	8-14
8-3	RS-449/MIL 188-114/MIL 188C Data Interface Pin Assignments for 37-Pin Connector	8-24
8-4	RS-449/MIL 188-114/MIL 188C Data Interface Pin Assignments for 9-Pin Connector	8-26
10-1	Receiver Filter Selections	10-3
10-2	Remote Control Command Options	10-12



SECTION 1

GENERAL INFORMATION

1.1 INTRODUCTION

This manual provides information for operators and users of the DATA SENTRY 10 Data Communications Analyzer manufactured by Telecommunications Techniques Corporation. Included in this manual are specifications, installation procedures, operating instructions, and applications information for the DATA SENTRY 10.

1.2 MANUAL AND INSTRUMENT IDENTIFICATION

This manual has an identifying part number: ML10423. The revision level of this printing is found in the upper right-hand corner of the title page.

Two stickers are attached to the rear panel of the DATA SENTRY 10. One sticker bears the serial number assigned to the instrument. The serial number is a sequentially assigned identifying number unique to that particular DATA SENTRY 10. The second sticker bears an alphanumeric configuration level identifier arranged in a letter-number-letter format. The first letter and the number describe the software and hardware revision levels of the instrument as a whole, and the final letter refers to the applicable manual revision level. The configuration level identifier is typically assigned to entire production runs.

The title page of this manual has a note stating to which configuration levels this manual applies.

1.3 INSTRUMENT DESCRIPTION

The DATA SENTRY 10 Data Communications Analyzer is a multifunction test set which performs a variety of test functions including error analysis, message generation, data trapping, and voice frequency (VF) measurements. The DATA SENTRY 10 allows manual and automated testing of modems, multiplexers, terminals, printers and a variety of other communications devices.

The DATA SENTRY 10 is packaged in a rectangular aluminum box with textured vinyl covering on the top, bottom, and sides. The unit measures 17" wide by 5 1/4" high by 14" deep (43.2 x 13.3 x 35.6 cm) without covers and weighs approximately 18 lbs. (8 kg) when all options are installed. Side handles along with front and rear covers are provided for portability. Flip-up bail feet allow the unit to be adjusted to a convenient viewing angle.

Front panel components include an optional printer, two seven-digit alphanumeric displays, one eight-digit alphanumeric display, various controls and LED indicators.

The unit operates in full or half duplex configurations and with synchronous, recovered, or asynchronous timing. Transmit timing may be supplied externally or from the internal frequency synthesizer. The unit will operate at any rate from 10 bps to 500 kbps for synchronous or recovered timing and 10 bps to 20 kbps for asynchronous operation.

The following data generation and analysis capabilities are provided:

- * BERT functions: BER, Errors, Blocks, Block Errors, Error Free Seconds, Seconds of Test, Character Errors, Clock Slips, Messages Received, Messages Received with Errors, Preambles Missed, Parity Errors, and Framing Errors.
- * Distortion Measurements: Peak Early and Late Telegraph Distortion, Telegraph Distortion due to Jitter, Bias Distortion.
- * Frequency Measurements: Audio (optional), Transmit Clock, and Receive Clock.
- * Delay Measurements: The delay between selected signaling lead or external input signal transitions, the delay between transmit and receive data, or the delay between the start or end of transmission and receipt of a trap sequence may be measured.
- * Audio Level: As an option, power level may be measured and displayed in dBm for tones, noise, and noise with tone, using flat or weighted filters.
- * Message Generation: A Fox message is available in Baudot, BCDIC, ASCII, or EBCDIC. The user may also program up to 4 messages, in any code, up to 85 characters each.
- * Data Trapping: The unit is capable of capturing data conditioned upon the receipt of a one to four character trap sequence. Up to 128 characters preceding and following the trap sequence may be displayed or printed. Alternatively, the unit may be instructed to store and display the first 255 characters received.

A panel mounted alphanumeric thermal printer is available as an option. When this option is not selected, a blank off plate is installed in place of the printer assembly. Printer controls are provided even when the printer option is not provided.

An RS-232 Printer/Controller interface is provided as standard equipment. This interface receives the same data as the internal printer and provides remote control capability. IEEE-488 and HP-IL interfaces, providing capability similar to the RS-232 interface, are available as options.

Up to ten sets of front panel control settings may be stored internally and recalled at any time.

A real time clock is provided as a standard feature. The time is maintained with the power off.

Interfacing to the system under test is accomplished through plug-in data interfaces in the rear of the unit. Each interface contains both DTE and DCE connectors; no adaptor cables are required.

1.4 EQUIPMENT SUPPLIED

The following are provided as standard equipment:

- * DATA SENTRY 10 mainframe
- * Front and rear snap-in covers
- * Three-conductor AC power cord, 2m (6 ft.) in length
- * Operating manual, part number ML10423.

1.5 OPTIONS AVAILABLE

The following options are available for the DATA SENTRY 10:

- * Option 10387 - Thermal Printer. This 20-column alphanumeric printer mounts through the DATA SENTRY 10 front panel.
- * Option 10454 - High Stability Time Base. This option increases the master time base accuracy to ± 7 ppm (0 to 45°C).
- * Option 40336 - IEEE-488 Remote Control Interface. This option complements the standard RS-232 Remote Control capabilities.
- * Option 40338 - HP-IL Remote Control Interface. This option complements the standard RS-232 Remote Control capabilities.
- * Option 40340-01 - Voice Frequency Measurement Module, North American Version.
- * Option 40340-02 - Voice Frequency Measurement Module, CCITT Version.
- * Model 10412 - Soft Carrying Case
- * Model 10413 - Rack Mount Kit
- * Model 10213 - RS-232/V.24 6 ft. (1.8m) Male-to-Male Cable
- * Model 10418 - RS-232/V.24 10 ft. (3m) Male-to-Male Cable
- * Model 10214 - V.35/306 6 ft. (1.8m) Male-to-Male Cable
- * Model 10419 - V.35/306 10 ft. (3m) Male-to-Male Cable
- * Model 10215 - RS-449/Military 6 ft. (1.8m) Male-to-Male Cable
- * Model 10417 - RS-449/Military 10 ft. (3m) Male-to-Male Cable
- * Model 10496 - RS-449/Military 6 ft. (1.8m) 37-pin Male to 25-pin Male Adaptor Cable
- * Model 10217 - 12 Rolls of Printer Paper
- * Model ML10423 - Extra Operating Manual

1.6 ACCESSORIES AVAILABLE

The following accessories are available for use with the DATA SENTRY 10:

- * Model 40342 - RS-232C/V.24 Data Interface
- * Model 40344 - V.35/306 Data Interface
- * Model 40346 - RS-449/MIL-188-114/MIL-188C Data Interface
- * Model 10411 - Hard Shipping Case



SECTION 2

SPECIFICATIONS

2.1 MODES OF OPERATION

Interconnection:	* Emulate DTE mode (for connection to DCE) * Emulate DCE mode (for connection to DTE)
System Configuration:	* Full Duplex mode * Half Duplex Continuous mode * Half Duplex Single mode * Single Transmit mode * Self Loop mode
Receiver Functions:	* Trap mode * Analyze (Error Analysis) mode
Timing Modes:	* Synchronous Timing * 16x Asynchronous (start-stop) Timing * 1x Asynchronous (start-stop) Timing * Recovered Timing

2.2 GENERATOR

2.2.1 Generator Timing System

Timing Modes:	* Synchronous (1x bit rate clock generated for bit rates from 10 to 500,000 bits per second) * 16x Asynchronous (16x bit rate clock used by USART for bit rates from 10 to 20,000 bits per second) * 1x Asynchronous (1x bit rate clock used by USART for bit rates from 10 to 20,000 bits per second) * Recovered (1x bit rate clock generated for bit rates from 10 to 500,000 bits per second)
Timing Sources:	* Internal Synthesizer * EXT CLK IN rear panel BNC connector * Data Interface

Indicator:

- * Red LED mounted in TIMING switch illuminates when no generator clock signal is present.

2.2.1.1 Frequency Synthesizer

Frequency Range:

- * 10.00 Hz to 500.0 kHz (16x bit rate clock generated in the 16x Asynchronous Timing mode for bit rates from 10 to 20,000 bits per second)

Resolution:

- * 4 significant digits

Accuracy and Stability:

- * ± 35 ppm from 0° to 45°C
(± 7 ppm from 0° to 45°C with Option 10454)

2.2.1.2 EXT CLK IN Rear Panel BNC Connector

Input Configuration:

- * Outer conductor - ground
- * Inner conductor - signal

Input Impedance:

- * 2000 ohms minimum

Input Threshold:

- * 1.4 volts nominal

Input Signal Range:

- * -15 to +15 volts maximum

2.2.1.3 GEN CLK OUT Rear Panel BNC Connector

Output Configuration:

- * Outer conductor - ground
- * Inner conductor - signal

Output Load:

- * 50 ohms minimum

Output Signal Levels:

- * TTL Levels - 2.0 volts minimum high level, 0.4 volts maximum low level (50 ohm load)
- * TTL Levels - 2.4 volts minimum high level, 0.4 volts maximum low level (1000 ohm load)

2.2.2 Data Generator

Fixed Patterns:

- * Mark
- * 1:1 (reversals)
- * PREAM ONLY (user selectable 5-, 6-, 7-, or 8-bit repeating pattern)

Pseudorandom Patterns:

- * 63 (2^6-1)
- * 511 (2^9-1)
- * 2047 ($2^{11}-1$)
- * 4095 ($2^{12}-1$)

Messages:

- * FOX Message (in Baudot, BCDIC, ASCII, or EBCDIC depending on code level selected)
- * 4 User-programmable messages, each up to 200 characters in length

Character Format (Messages and/or Asynchronous Timing mode):

- * Code Level - 5, 6, 7, 8 bits
- * Parity - odd, even, none
- * Stop Bits (Asynchronous Timing only) - 1, 1.5, 2 bits

Preamble Capability (Messages and/or Asynchronous Timing mode):

- * Up to 4 user-selectable characters preceding each transmission

Data Inversion:

- * Independently available by Auxiliary Function for transmitted and received data

Error Insertion:

- * Single error or fixed 10^{-3} bit error rate

Full Duplex Bit Rates:

- * Messages and/or Asynchronous Timing mode - 10 to 20,000 bits per second
- * Other timing modes - 10 to 500,000 bits per second

Half Duplex Bit Rates:

- * Synchronous or Asynchronous Timing modes - 10 to 20,000 bits per second
- * Recovered Timing mode - 10 to 9999 bits per second

2.3 RECEIVER

2.3.1 Receiver Timing System

Timing Modes:

- * Synchronous (1x bit rate clock received through data interface for bit rates from 10 to 500,000 bits per second)
- * 16x Asynchronous (16x bit rate clock internally provided for USART for bit rates from 10 to 20,000 bits per second)
- * 1x Asynchronous (1x bit rate clock received through data interface for bit rates from 10 to 20,000 bits per second)
- * Recovered (1x bit rate clock recovered from data transition information)

Timing Sources:

- * Data Interface
- * Clock Recovery System (16x Asynchronous or Recovered Timing modes)

Indicator:

- * Green CLK ACT LED illuminates when receiver clock is present

2.3.1.1 Clock Recovery System

Bit Rates:

- * 1x bit rate clock recovered from data transition information for bit rates from 10 to 500,000 bits per second (Recovered mode)
- * 16x bit rate clock generated for bit rates from 10 to 20,000 bits per second (16x Asynchronous mode)

Resolution:

- * 4 significant digits

Clock Recovery Acquisition/ Tracking Range:

- * $\pm 1\%$ of selected bit rate typical

2.3.2 Data Error Analysis

Indicators:

- * Receiver Inputs - CLK ACT
 MK
 SP
 DATA INV
- * IN SYNC
- * SYNC LOST (latching with pushbutton reset)

Sync Acquisition Criteria (Synchronous, Recovered Timing modes):

- * Pseudorandom, fixed patterns - 32 consecutive bits received with no errors
- * Messages - 10 consecutive characters received with no errors. In Half Duplex, if message length is less than 10 characters, one half message length (minimum 1 character) received with no errors

Sync Acquisition Criteria (Asynchronous mode):

- * Pseudorandom, 1:1 patterns - 32 consecutive bits received with no errors
- * Messages, Mark, PREAM ONLY - 10 consecutive characters received with no errors. In Half Duplex, if message length is less than 10 characters, one half message length (minimum 1 character) received with no errors

Sync Loss Criteria (Synchronous, Recovered Timing modes):

- * Pseudorandom, fixed patterns - 32 or more errors occurring in 128 or fewer bits. (240 or more errors occurring in 1024 or fewer bits plug jumper selectable)
- * Messages - 10 consecutive characters received in error. In Half Duplex, if message length is less than 10 characters, one half message length (minimum 1 character) received in error

Sync Loss Criteria
(Asynchronous mode):

- * Pseudorandom, 1:1 patterns - 32 or more errors occurring in 128 or fewer bits. (240 or more errors occurring in 1024 or fewer bits plug jumper selectable)
- * Messages, Mark, PREAM ONLY - 10 consecutive characters received in error. In Half Duplex, if message length is less than 10 characters, one half message length (minimum 1 character) received in error

2.3.2.1. Full Duplex Error Analysis

Test Results Available:

- * Errors count
- * Bit error rate (BER)
- * Blocks count
- * Block errors count
- * Seconds of test
- * Error-free seconds of test
- * Character errors count (Asynchronous Timing mode and Messages)
- * Clock slips count (Synchronous and Recovered Timing mode with pseudorandom patterns)

BER Test Intervals:

- * $10^3, 10^4, 10^5, 10^6, 10^7, 10^8$ bits

Block Lengths:

- * PREAM ONLY - 5 to 8 bits
- * Fixed patterns - 1000 bits
- * Psuedorandom patterns - pattern length
- * Messages - message length
- * By Auxiliary Function, variable from 63 to 65,535 bits

2.3.2.2 Half Duplex Error Analysis

Test Results Available:

- * Errors count
- * Blocks analyzed count
- * Blocks count
- * Block errors count
- * Seconds of test
- * Preambles missed count
- * Character errors count (Asynchronous Timing mode and Messages)

Half Duplex Time Delays:

- * Three user-selectable, each from 0 to 999 milliseconds

Transmit and Receive
Block Lengths:

- * PREAM ONLY - 5 to 8 bits
- * Psuedorandom patterns - 1000 bits, or (by Auxiliary Function) pattern length
- * Messages - message length

2.3.3 Frequency Measurements

Frequency Range:

- * 10 to 500,000 Hz minimum

Frequency Measurement
Intervals:

- * Three, selectable by Auxiliary Function
- * 1 second FMI gives 1 Hz resolution
- * 10 second FMI gives 0.1 Hz resolution
- * 100 second FMI gives 0.01 Hz resolution

Timebase Accuracy

- * ± 35 ppm standard
- * ± 7 ppm with Option 10454

2.3.4 Distortion Measurements

Distortion Measurements:

- * Peak Telegraph Distortion (Recovered Timing Mode)
- * Telegraph Distortion due to jitter (Recovered Timing Mode)
- * Gross Start-Stop Distortion (Asynchronous Timing Mode)
- * Bias Distortion (all modes)

Bit Rate Range:

- * Telegraph Distortion - 10 to 9999 bits per second
- * Stop-Start Distortion - 10 to 9999 bits per second
- * Bias Distortion - 10 to 500,000 bits per second

2.3.4.1 Telegraph Distortion and Start-Stop Distortion

Display Format:

- * Simultaneous display of early and late distortion as a percentage of a bit period

Scale:	* 0 to 50% Early and 0 to 50% Late
Measurement Interval:	* 2 seconds * Maximum early and late values since test start displayed once every 12 seconds
Accuracy:	* Within 2% typically

2.3.4.2 Bias Distortion

Scale:	* 100% Mark (all Mark) to 0% to 100% Space (all Space)
Accuracy:	* Within 1% typically
Display Update:	* Twice per second

2.3.5 Delay Measurements

Start of Measurement Signal Sources:	* DTR * DSR * RTS * CTS * CD (RLSD) * Generated data * Generator activity * Input X (rear panel)
End of Measurement Signal Sources:	* DTR * DSR * RTS * CTS * CD (RLSD) * Receiver data * Detection of trap characters * Input Y (rear panel)
Edge Selection:	* Rising (off to on) or falling (on to off) edge selectable for both start and end of measurement signals
Measurement Range:	* 0 to 9999 milliseconds
Accuracy:	* $\pm$ 1 millisecond

2.3.6 Data Trapping

Modes of Operation:	* Full Duplex or Half Duplex, up to 20,000 bits per second
Trap Sequences:	* User selectable, 1 to 4 characters, 5, 6, 7, or 8 bit code level, or * First data transition
Trap Length:	* 128 characters preceding trap sequence and 128 characters following trap sequence, or * First 255 received characters
Indicator:	* TRAP DETECT LED illuminates upon trap detection

2.4 VOICE FREQUENCY MEASUREMENT MODULES (OPTIONS 40340-01 AND 40340-02)

Note: For complete specifications, see Section 10.

2.4.1 Transmitter

Output Impedance:	* 600 ohms
Level Range:	* -40 dBm to +10 dBm with 1 dB resolution
Frequency Range:	* 200 Hz to 3906 Hz with 1 Hz resolution.
Transmit Sweep:	* 204 Hz to 3904 Hz, 100 Hz per step with 4 Hz offset; 7 seconds per step. * Selectable SF skip omits 2504 Hz, 2604 Hz, and 2704 Hz from sweep.

2.4.2 Receiver

Input Impedances:	* 600 ohms (terminated). * High impedance (bridging).
-------------------	---

Level and Frequency Measurement Range:	* -40 dBm to +10 dBm. * 80 Hz to 4000 Hz.
Noise Measurement Range:	* -75 dBm (15 dBrn) to +10 dBm (100 dBrn).
Noise Weighting Filters:	* 3 kHz flat. * C-Message (-01 version). * Psophometer (-02 version). * 1010 Hz Notch (-01 version). * 820 Hz Notch (-02 version).

2.5 PROGRAMMABILITY

2.5.1 User Defined Messages

Number of Programmable Messages:	* 4 (USER 1, USER 2, USER 3, USER 4)
Message Length:	* 1 to 200 characters
Entry Format:	* One hex character pair per transmitted character
Output Format:	* 5, 6, 7, or 8 level code, depending on CODE LEVEL switch position.

2.5.2 Front Panel Programs

Number of Front Panel Programs:	* 10
Functions Under Program Control:	* Front panel switch settings, keypad entries (SYNTH FREQ, etc.), auxiliary functions.
Access:	* Program entry and program recall via the "PROG" position of the DISPLAY/ENTRY switch.

2.5.3 Non-Volatile Memory

Information Stored:

- * Current front panel switch settings, keypad entries, auxiliary functions
- * 4 user defined messages
- * 10 front panel programs
- * Time and date of last power-down

Memory Life:

- * Typically greater than 7 years

2.6 REMOTE CONTROL CAPABILITY

Remote Control Access:

- * RS-232 Printer/Controller connector
- * Optional HP-IL Interface
- * Optional IEEE-488 Interface

Remote Control Indicators:

- * LOCAL LED illuminates when unit is under front panel control
- * REMOTE LED illuminates when unit is under external remote control

Controllable Functions:

- * Front panel switch settings
- * Keypad entries
- * Auxiliary functions
- * User defined messages
- * Internal and external printers
- * Data Interface switch settings

2.7 DATA INTERFACES

2.7.1 RS-232C/V.24 Data Interface

Connectors:

- * Two 25-pin D-subminiature female connectors
- * One for DTE emulation labeled "TO DCE"
- * One for DCE emulation labeled "TO DTE"

Signal Format:

- * Bipolar, unbalanced

Data Bit Rates:

- * 10 to 20,000 bits per second per EIA RS-232C and CCITT V.28
- * Operates above 20,000 bits per second as noted in Section 8.2

2.7.2 V.35/306 Data Interface

Connectors:	* Two 34-pin female connectors * One for DTE emulation labeled "TO DCE" * One for DCE emulation labeled "TO DTE"
Data and Clock Format:	* Bipolar, balanced
Signaling Format:	* Bipolar, unbalanced
Data Bit Rates:	* 10 to 500,000 bits per second

2.7.3. RS-449/MIL-188-114/MIL-118C Data Interface

Operating Modes:	* MIL-188C * MIL-188-114 Unbalanced (RS-423) * MIL-188-114 Balanced (RS-422) Unterminated * MIL-188-114 Balanced (RS-422) Terminated
Connectors:	* Two 37-pin D-subminiature female connectors * Two 9-pin D-subminiature female connectors for secondary channel operation * One pair for DTE emulation labeled "TO DCE" * One pair for DCE emulation labeled "TO DTE"
Data Formats:	* Bipolar, unbalanced (MIL-188C, MIL-188-114 Unbalanced) * Bipolar, balanced (MIL-188-114 Balanced, Untermated and Terminated)
Data Bit Rates:	* 10 to 65,000 bits per second (MIL-188C) * 10 to 130,000 bits per second (MIL-188-114 Unbalanced) * 10 to 500,000 bits per second (MIL-188-114 Balanced, Untermated or Terminated)

2.8 REAR PANEL CONNECTORS AND TEST POINTS

2.8.1 Audio Output Test Points

Test Points	* AUDIO OUT + * AUDIO OUT -
Intended Use:	* External speaker drive
Load Impedance:	* 8 ohms minimum
Power Output:	* 100 mW typical, level controlled by front panel AUDIO LEVEL control

2.8.2 X and Y Input Test Points

Test Points:	* X * Y
Intended Use:	* Delay measurement start and end signals
Input Impedance:	* 2000 ohms minimum
Input Levels:	* Logic high: + 2.0v minimum + 15.0v maximum * Logic Low: + 1.0v maximum - 15.0v minimum * Pullup resistor to +5v gives logic high for open circuit

2.8.3 Alarm Test Points

Test Points:	* BER ALARM * RCVR FREQ ALARM
Logic Low Output:	* 0.4v max at 100 mA or less * 0.7v max at 300 mA or less
Logic High Output:	* Open collector with 27K pullup to +5v

2.8.4 Miscellaneous Test Points

Test Points:

- * RCVR CLK
- * RCVR DATA
- * GEN CLK
- * GEN DATA
- * GEN PATT SYNC
- * GEN ACTIVE
- * RCVD BLK SYNC
- * ERROR

Logic Low Output:

- * 0.5v max at 8 mA or less

Logic High Output:

- * 2.7v min at 0.4 mA or less

2.9 REAL TIME CLOCK

Displayed Clock Functions:

- * Hours (24-hour format)
- * Minutes
- * Colon blinks to indicate seconds

Printed Clock Functions:

- * Month
- * Day
- * Year
- * Hours (24-hour format)
- * Minutes
- * Seconds

Accuracy:

- * Typically better than one second per day

2.10 POWER REQUIREMENTS

Voltage:

- * User selectable - 100, 120, 220, 240 VAC

Voltage Tolerance:

- * $\pm 10\%$ of selected voltage

Frequency:

- * 48 to 66 Hz

Power:

- * 100 volt-amperes maximum

2.11 ENVIRONMENTAL SPECIFICATIONS

Operating Temperature Range: * 0°C (+ 32°F) to + 45°C (+ 113°F)

Storage Temperature Range: * -30°C (-22°F) to + 75°C (+ 167°F)



SECTION 3

PREPARATION FOR USE

3.1 INTRODUCTION

This section provides unpacking and initial inspection instructions, power requirements, and instrument environmental requirements for the DATA SENTRY 10.

3.2 UNPACKING AND INITIAL INSPECTION

Inspect the shipping container for damage. If the shipping container is damaged it should be kept until the instrument can be checked mechanically and electrically. Procedures for checking electrical performance are given in Section 6. Refer to the Safety Warning Section at the front of the manual before either performing the electrical checkout or using the DATA SENTRY 10. Notify TTC if the DATA SENTRY 10 does not pass the checkout procedures or if the contents are incomplete. If the container is damaged, notify the carrier as well as TTC. Keep the shipping materials for the carrier's inspection.

3.3 RACK MOUNTING INSTRUCTIONS

If the DATA SENTRY 10 is to be installed in a rack mount configuration, refer to the Rack Mount Option in Section 11.

Adequate ventilation is required for rack mounted instruments. The ventilation holes must not be obstructed and the ambient temperature within the rack must not exceed 45°C.

3.4 POWER REQUIREMENTS

////////////////////

WARNING

This instrument is equipped with a 3-pin power receptacle. When used with a properly wired power cable and 3-conductor outlet, the center pin of this receptacle connects the instrument chassis to earth ground. Improperly grounded equipment can create a shock hazard, with hazardous potentials on the instrument.

////////////////////

The DATA SENTRY 10 requires a power source of 100, 120, 220, or 240 volts AC $\pm 10\%$, single phase, 48 to 66 Hertz that can deliver 100 volt-amperes. The instrument is normally shipped from the factory set to operate from a 120 volt power source. To operate the instrument from a different source voltage, proceed as follows:

- a. Remove the input power cord.
- b. Slide the plastic door to the left.
- c. Remove the fuse.
- d. Pull the voltage select card straight out.
- e. Change the orientation of the voltage select card and reinsert so the appropriate operating voltage is visible on the card after it has been installed.

////////////////////
WARNING

For continued protection against fire hazards, use only the specified fuse values.

////////////////////////////////////

- f. Install the appropriate size fuse (See Table 3-1).
- g. Slide the plastic door to the right and reinsert power cord.

3.5 CHASSIS AND CIRCUIT GROUNDS

For DATA SENTRY 10s with serial numbers 0099 and below, chassis and circuit grounds are permanently strapped together. For instruments with serial numbers 0100 and above, chassis and circuit grounds are separated by a 100 ohm, 1/2 watt resistor. If desired, chassis and circuit grounds may be strapped together by moving plug jumper JW11, located on the motherboard near the rear panel "AUXILIARY" opening.

3.6 OPERATING ENVIRONMENT

The DATA SENTRY 10 can be operated in ambient temperatures within the range of 0°C to 45°C. Care should be taken to insure that there is unrestricted air flow around the vent holes or the instrument may overheat.

CAUTION

Operating the DATA SENTRY 10 at temperatures outside the specified range may damage the instrument.

CAUTION

Spilling or dropping foreign material into the ventilation holes of the DATA SENTRY 10 may damage internal circuitry.

Table 3-1. Fuse Selections

<u>Operating Voltage</u>	<u>Fuse Size</u>	<u>Fuse Type</u>
100	1 amp 250V	3AG
120	1 amp 250V	3AG
220	1/2 amp 250V	3AG
240	1/2 amp 250V	3AG

SECTION 4

FUNCTIONAL DESCRIPTION

4.1 INTRODUCTION

In this section, a functional description of the DATA SENTRY 10 is given. The instrument's generation and measurement capabilities are described and the various modes of operation are discussed. An extensive description of the front panel controls, indicators, and displays is given in this section, as is a description of the rear panel connectors, test points and controls.

4.2 GENERATION CAPABILITY

The following sections describe the data generation capabilities of the DATA SENTRY 10.

4.2.1 Fixed Patterns

Three types of fixed patterns may be selected using the DATA switch:

- * continuous Mark ("MK")
- * reversals ("1:1")
- * repeating character transmission ("PREAM ONLY")

A preamble of up to four characters long may be entered through the keyboard as described in Section 4.5.1. In addition to the normal use of the preamble discussed in Section 4.2.5, the DATA SENTRY 10 allows the last code character of the preamble to be transmitted repetitively when the DATA switch is set to "PREAM ONLY." The repeated code character has

a length of 8 bits and is sent in its entirety when Synchronous or Recovered timing is selected. When Asynchronous timing is chosen, the setting of the CODE LEVEL switch determines the number of bits of the preamble characters that are transmitted. Thus, if the CODE LEVEL switch is set to "6", the test set will repetitively send an asynchronous character (framed with start and stop bits) whose 6 information bits correspond to the 6 least significant bits of the last preamble character. If desired, the PARITY switch may be set so that a parity bit is added to the asynchronous character thus generated. In this manner, any 5, 6, 7, or 8 level code character may be sent repetitively in the Asynchronous timing mode.

4.2.2 Psuedorandom Patterns

Four different psuedorandom patterns may be selected using the DATA switch:

- * 2^6-1 ("63")
- * 2^9-1 ("511")
- * $2^{11}-1$ ("2047")
- * $2^{12}-1$ ("4095")

Each psuedorandom pattern is a maximal length sequence generated from a feedback shift register of length n ($n = 6, 9, 11, \text{ or } 12$). The generated sequence repeats every 2^n-1 bit periods, and has the property that no more than n sequential ones (Marks) or $n-1$ sequential zeros (Spaces) will ever occur.

The psuedorandom patterns are generated by using the following shift register taps:

63 : Q6 ⊕ Q5
511 : Q9 ⊕ Q5
2047 : Q11 ⊕ Q9
4095 : Q12 ⊕ Q11 ⊕ Q8 ⊕ Q6

Jumper wires are provided to allow reverse psuedorandom patterns to be generated in the Full Duplex Synchronous and Recovered Timing modes, using the following shift register taps:

63 : Q6 ⊕ Q1
511 : Q9 ⊕ Q4
2047 : Q11 ⊕ Q2
4095 : Q12 ⊕ Q6 ⊕ Q4 ⊕ Q1

Contact TTC for modification instructions to obtain these reverse patterns.

4.2.3 Messages

Five different messages are selectable using the DATA switch: a FOX message and four user programmable messages (switch positions "USER 1" through "USER 4").

A FOX message is available for transmission in all timing modes in 5, 6, 7, or 8 level code. The specific code used by the test set is determined by the position of the CODE LEVEL switch as follows:

5 level - Baudot
6 level - BCDIC
7 level - ASCII
8 level - EBCDIC

An optional parity bit is user selectable in all timing modes and the number of stop bits per character is user selectable in the Asynchronous timing mode only.

The FOX message takes this form:

THE QUICK BROWN FOX JUMPS OVER
THE LAZY DOG 1234567890(CR)(LF)

In 5 and 6 level code, the entire FOX message is preceded by the LTRS or UPPER command and the numbers in the FOX message are preceded by the FIGS or LOWER command. One or two synchronizing character groups (see Section 4.6.5.5) are also transmitted preceding the FOX message in the Synchronous and Recovered timing modes only.

Through the use of Auxiliary Functions 41 through 44 (see section 4.6.4), the user may program and store up to 4 messages in 5, 6, 7, or 8 level code which may be selectively transmitted at some future time in any timing mode. Each message is limited to a maximum length of 200 characters.

For message entry purposes, each code character is represented by two hexadecimal characters. A conversion chart from hexadecimal characters to the corresponding 5, 6, 7, and 8 level standard code characters is supplied as Appendix B of this manual.

When a user defined message is entered into the test set's memory, only the information bits of each character are stored. This leaves the user free to select the code level and parity (as well as the number of stop bits in Asynchronous mode) each time a user defined message is chosen for transmission. When the code level switch is set to 5, 6, or 7 the 5, 6, or 7 least significant bits of each hex character pair are transmitted. The hex character pair is transmitted in its entirety when an 8 level code is chosen. The data bits within each code character are always transmitted in order of increasing significance.

In the Synchronous and Recovered Timing modes, all transmitted messages are preceded by one or two SYN character groups. The characters within each SYN character group, the number of character groups, and the line idling option are selectable for each of the four code levels through Auxiliary Function 70.

All messages are limited to a maximum data rate of 20 kbps.

4.2.4 Character Format

All data transmitted in the Asynchronous timing mode and all messages transmitted in the Synchronous and Recovered timing modes are in character format.

The CODE LEVEL switch is used to determine the number of information bits contained in each character. Code levels of 5, 6, 7, and 8 may be selected.

A parity bit may be added to each character by setting the PARITY switch to "ODD" or "EVEN." The parity bit immediately follows the most significant information bit in each character. When the PARITY switch is set to "NONE," no parity bit is inserted and the overall character length is one bit smaller than when even or odd parity is selected.

In the Asynchronous timing mode, all transmitted data are formatted into characters. The number of information bits contained in each character is determined by the position of the CODE

LEVEL switch. In all cases, these information bits (plus an optional parity bit) are framed by one start bit (a Space) and a selectable number of stop bits (Marks). The user may select 1, 1.5, or 2 bits using the STOP BITS switch. When pseudorandom data is sent in the Asynchronous timing mode, the transmitted order of the information bits is exactly the same as when Synchronous or Recovered timing is chosen. With Asynchronous messages, the information bits of each character are sent in order of increasing significance, the least significant bit immediately following the start bit. In all cases in which a parity bit is sent, this bit immediately follows the most significant information bit and consequently immediately precedes the stop bit(s).

4.2.5 Preambles

Any character formatted data* may be preceded by a preamble up to four characters long. The desired preamble may be entered via the "PREAM" position of the DISPLAY/ENTRY switch as described in section 4.5.1.10.

In the Single Transmit and Half Duplex Single modes of operation, the preamble and the selected pattern or message are transmitted once. In the Half Duplex Continuous mode of operation, the preamble and the selected pattern or message will be transmitted each time the line is turned around. In the Full Duplex mode of operation, the preamble is transmitted only once, while the selected pattern or message repeats continuously.

*Except PREAM ONLY in Half Duplex operation.

In addition to the preambles, SYN character groups will precede messages (only) transmitted in the Synchronous and Recovered Timing modes to provide character synchronization. The order of transmission is:

1. Preambles, if selected
2. SYN characters
3. Transmitted message
4. SYN characters (FDX only)
5. Transmitted message (FDX only)
6. Repeat 4 and 5 (FDX only)

4.2.6 Data Inversion and Error Insertion

Auxiliary Function 06 allows all transmitted data to be inverted. This function allows the transmission of an all-space pattern, characters with inverted start and stop bits, etc.

Errors may be inserted into the transmitted data stream singly or at a constant 10^{-3} bit error rate. A single error is forced in the data upon a momentary depression of the front panel ERROR INSERT switch. If the switch is held down for more than one second, the 10^{-3} error insert circuitry is activated, as indicated by the illumination of the "10⁻³" indicator. This constant error rate insertion is accomplished by inverting one bit in every 1000 bits of transmitted data. The 10^{-3} error insert circuitry is deactivated the next time the ERROR INSERT switch is depressed, as indicated by the "OFF" LED.

In Half Duplex operation, setting the ERROR INSERT switch to "10⁻³" causes one error to be inserted in each transmitted block.

The parity, start, and stop bits of character formatted data are not affected by the error insertion circuitry; errors are inserted only in the information bits. It should be noted that a 10^{-3} bit error rate will give rise to a considerably higher character error rate. The character error rate is given by:

$$\text{character error rate} = \text{code level} \times 10^{-3}$$

Thus, the number of characters in error in a 1000 character test segment will be approximately equal to the code level (number of information bits per character).

4.2.7 Signaling Interaction

Data transmission will normally not begin until certain signaling conditions are met. See Section 5.3.14 for a discussion of signaling interaction.

4.3 MEASUREMENT CAPABILITY

The following sections describe the measurement capabilities of the DATA SENTRY 10, and define each measurement.

4.3.1 Error Analysis

The following measurements are made in some or all operating modes when the RCVR FUNCTION switch is in the "ANALYZE" position.

4.3.1.1 Errors

Errors are counted in all operating modes (except Trap) with all types of patterns or messages except PREAM ONLY. Errors are only counted after SYNC has been acquired. An Error is defined as a received bit whose value is opposite of that which was expected for the particular pattern or message selected.

4.3.1.2 Bit Error Rate (BER)

Bit Error Rate (BER) is defined as the number of errors counted divided by the total number of bits used to perform the measurement.

Bit error rate is measured cyclically over a number of bit periods determined by the setting of the BER INTVL switch. At any time when an insufficient quantity of data has been analyzed since the start of the test to provide a BER result, the display will remain blank when the BER position is selected. The display format gives an indication of how many errors were detected in the interval. (See Table 4-1.)

BER measurements are updated at the end of every measurement interval, meaning that any errors in the incoming data will not be reflected in the BER result until the end of the interval in which the errors occurred. At slow data rates and/or long BER

Table 4-1
BER Display Format

<u>Display Format</u>	<u>No. of Bit Errors In Interval</u>
X. E-X	0-9
X.X E-X	10-99
X.XX E-X	more than 99

intervals, this delay may be significant. A tone sequence from the test set's internal loudspeaker signifies the end of each BER interval when the BER position is selected.

Auxiliary Function 62 allows the user to set a BER threshold which, when exceeded, will cause a TTL alarm signal present on the "BER ALARM" test point to change from a logic high to a logic low. This test point is driven by an opencollector gate (with pullup resistor) capable of sinking up to 300 mA, and thus may be used to drive a relay or other high-current device.

4.3.1.3 Blocks

A block is counted each time the number of bits received since the end of the last block equals the block length. In the Full Duplex mode, the block length normally equals the selected pseudorandom pattern or message length, 5 to 8 bits for PREAM ONLY, or 1000 bits for other fixed patterns. Auxiliary Function 64 (see Section 4.6) allows the user to select any block length between 63 and 65,535 bits.

In the Half Duplex mode, the block length is fixed at the message length for messages and one character for preamble only. For pseudorandom patterns the block length is normally equal to 1000 bits, but Auxiliary Function 24 may be used to select a block length equal to the pattern length instead. In the Half Duplex mode of operation, the number of blocks to which the receiver has properly synchronized and on which error analysis has been performed is displayed in the "BLKS ANALYZED" switch position.

4.3.1.4 Block Errors

A block error is counted for each block which contains one or more bit errors. In the Full Duplex mode, the block errors count shows the number of blocks containing one or more bit errors received since the beginning of the test. In the Half Duplex mode, the block errors count shows the number of blocks analyzed since the beginning of the test containing one or more bit errors.

4.3.1.5 Character Errors and Parity Errors

A character error is counted for each received character containing one or more bit errors. A character error can be considered as a block error, where the block length is equal to the code level of the character. Character error counts are available for data in character format - in the Asynchronous timing mode and with messages in all timing modes.

An approximate count of parity errors is provided whenever the data is in character format and even or odd parity is selected. The measured parity error count will differ from the actual number of parity errors only in high parity error rate situations. In all cases, the measured count will be equal to or less than the actual parity error count. The parity error count is available only as a printed result.

4.3.1.6 Clock Slips

A clock slip occurs when the received data has "moved" forward or backward with respect to the accompanying clock

signal, i.e., when a data bit has been clocked twice or when a data bit has not been clocked.

The clock slip count shows the number of times the clock and data have lost phase synchronization due to clock slips (not due to data dropout, high error rates, etc.). The clock slip count is available only with pseudorandom patterns in the Synchronous and Recovered timing modes. Section 5.3.8.2 discusses in detail the effect of clock slips on synchronization and error counts.

4.3.1.7 Preambles

In the Half Duplex mode for messages using Synchronous and Recovered timing, the count of preambles missed equals number of blocks since the beginning of the test in which the SYN characters contain one or more bit errors. For all other modes of operation, the count of preambles missed is the number of blocks in which the last character of the preamble contained one or more bit errors. The preamble missed count is not available in Full Duplex mode or when no preamble is sent.

4.3.1.8 Seconds of Test

The time elapsed from the beginning of the test is measured and available for display. Section 5.3.9 defines when seconds are counted in each operating mode and receiver configuration.

4.3.1.9 Error-Free Seconds

An error-free second is counted at the end of each second of test during which no bit errors were counted. These

error-free seconds are asynchronous error-free seconds - errors may occur at any point during each second of test, and the errored seconds are not synchronized with the occurrence of errors.

4.3.2 Synchronization

4.3.2.1 Sync Acquisition

The DATA SENTRY 10 attempts to acquire synchronization automatically, using its autopolarity and receiver circuits. The autopolarity circuit is used to automatically correct any data inversion occurring in the system under test, and the receiver circuits synchronize to and detect any errors occurring in the received data stream. Note that the autopolarity circuit is not available in Half Duplex operation.

Auxiliary Function 07 (Receiver Data Invert) may be used to override the autopolarity circuit and force the received data to be inverted. This function is useful in the Half Duplex mode, or when rapid sync acquisition is desired and the system under test inverts the data. Once sync is acquired, the DATA INV LED will be lit.

For pseudorandom and some fixed patterns (see Section 2.3.2), the DATA SENTRY 10 will be declared "in sync" when 32 consecutive data bits have received with no errors. For messages (and some fixed patterns in the Asynchronous mode) sync is declared when 10 consecutive characters have been received with no errors. In Half Duplex operation, if the message length is less than 10 characters, one half the message characters (minimum 1 character) must be received with no errors before sync is declared. Once sync is acquired, the IN SYNC LED will be lit.

4.3.2.2 Sync Loss

When the received data stream contains an excessive number of errors, the DATA SENTRY 10 declares a sync loss. Upon a sync loss, the LED inside the SYNC LOST switch will be lit. This LED will remain lit after sync has been reacquired to provide an indication that sync had been lost sometime during the test. The LED may be turned off by pressing the SYNC LOST switch. The test in process is not affected by this switch.

After a sync loss, the autopolarity and autosync circuits are used to attempt to regain sync. Auxiliary Function 03 allows the autosync process to be disabled for operation in burst or high error rate environments (see Section 5.3.8.1). When the autosync process is disabled, the DATA SENTRY 10 will resynchronize only when a complete BER interval ends with a BER greater than or equal to 0.4 (4.00 E-1).

The DATA SENTRY 10 may respond in several different ways to a sync loss, depending on the mode of operation and the setting of Auxiliary Function 16. Section 5.3.8.3 discusses these responses in detail.

For pseudorandom and some fixed patterns (see Section 2.3.2), the DATA SENTRY 10 will declare a sync loss if 32 errors are detected in 128 or fewer received data bits. Plug jumpers may be moved (see Section 5.3.8.1) to change the sync loss criteria to 240 errors detected in 1024 or fewer received data bits.

For messages (and some fixed patterns in the Asynchronous mode) a sync loss will

be declared if 10 consecutive received characters are in error. In Half Duplex operation, if the message length is less than 10 characters, one half of the message characters (minimum 1 character) must consecutively be received in error for a sync loss to be declared.

4.3.3 Frequency Measurements

For the Synchronous, Recovered and 1x Asynchronous timing modes, the transmit and receive clock frequencies are continuously measured.

The frequency of the clock source selected by the GEN CLOCK switch is measured and displayed when the DISPLAY II switch is set to "GEN CLK FREQ." The generator clock is used to clock the transmitted data out of the data generator circuit, and thus its frequency corresponds to the bit rate of the data transmitted by the test set in all timing modes except the normal Asynchronous (16x clock) mode. In this mode, the generator clock frequency is measured and divided by 16 to provide a result equal to the transmitted bit rate.

When the DISPLAY II switch is set to "RCVR FREQ," the frequency of the clock associated with the data being received by the test set is displayed. This clock is either the clock accompanying the data (Synchronous timing and 1x Asynchronous timing) or the recovered clock (Recovered timing). No receiver frequency measurement is provided when normal 16x Asynchronous timing is selected.

Special considerations apply to frequency measurements made in Half Duplex

operation. These considerations and information on the resolution and accuracy of frequency measurements are discussed in Section 5.3.12.

4.3.4 Distortion Measurements

The following paragraphs describe the distortion measurements performed by the DATA SENTRY 10, and gives the definitions of the different types of distortion measured.

4.3.4.1 Bias Distortion

Bias distortion is defined as distortion affecting the relative durations of the Mark and Space binary states. A system is "Mark biased" when Marks have consistently greater duration than Spaces; a system is "Space biased" when Spaces have consistently greater duration than Marks.

Bias distortion measurements are displayed as percentages. An all-Mark pattern will cause "100% MK" to be displayed, an all-Space pattern will cause "100% SP" to be displayed, and a 1:1 pattern with no bias distortion (Mark and Space durations equal) will cause "0%" to be displayed.

Bias distortion measurements are traditionally made using a 1:1 pattern. When other patterns are used, the measurement results will reflect not only the bias distortion introduced by the system under test, but also the Mark-to-Space ratio of the pattern itself.

For example, a repeating 1:3 pattern (one Mark followed by three Spaces) with no

bias distortion will cause "50% SP" to be displayed, and a 63-bit pseudorandom pattern will cause "2% MK" to be displayed (there are 32 Marks and 31 Spaces per pattern repetition).

4.3.4.2 Telegraph Distortion

Telegraph distortion is defined as distortion affecting the time position of Mark-to-Space and Space-to-Mark data transitions relative to the expected, or ideal, transition times. The resulting distortion is expressed as a percentage of a bit time. Both Early (data transitions occurring before the ideal transition time) and Late (data transitions occurring after the ideal transition time) distortion is measured and displayed.

Two different values of telegraph distortion are displayed. When the "2 SEC MAX" LED is illuminated, the display shows the maximum Early distortion and the maximum Late distortion measured over the previous two second interval. When the "TEST MAX" LED is illuminated, the display shows the maximum Early and the maximum Late distortion measured since the START/RESTART switch was last depressed.

Telegraph distortion is measured in the Asynchronous and Recovered Timing modes for bit rates from 10 to 9999 bits per second.

4.3.4.2.1 Telegraph Distortion - Recovered Timing Mode

In the Recovered Timing mode, the clock recovery circuit phase-locks to the incoming data stream. The recovered clock is used to define the ideal data

transition times, and the actual data transitions are compared against the ideal transition times. Early transitions and Late transitions are measured and displayed.

Normally, the distortion measurement circuitry uses every data transition to determine the maximum Early and Late distortion values. Because the measured distortion reflects the effects of both bias distortion and jitter, the result is Peak Telegraph Distortion.

Auxiliary Function 23 can cause the distortion measurement circuitry to use one "edge" of the data (the Space-to-Mark transition) to determine the maximum Early and Late distortion values. By using only one "edge," the effects of bias distortion are removed, and the result is Telegraph Distortion due to jitter.

4.3.4.2.2 Telegraph Distortion - Asynchronous Timing Mode

In the 16x Asynchronous Timing mode, the clock recovery circuit does not phase-lock to the incoming data. A clock signal is generated at the user-specified receive frequency, and this clock is used to define the ideal data transition times. Because the time between received characters is variable, this clock is resynchronized to the beginning of each character. Because the expected receive bit rate and the actual receive bit rate may differ, this circuit measures gross stop-start distortion as defined in EIA Standard RS-404.

If the expected and actual receive bit rates are identical, the gross stop-start distortion values will be equal to the synchronous stop-start distortion values (also defined in RS-404). If the expected and actual receive bit rates are not identical, the gross stop-start distortion values will generally be larger than the corresponding synchronous stop-start values.

4.3.5 Delay Measurements

Each time the START/RESTART button is depressed, the delay counter is cleared and the test set is prepared to make a new delay measurement.

The measurement may be started on the rising or falling edge of any one of eight user selectable start-of-measurement signals, and is terminated on the rising or falling edge of one of eight end-of-measurement signals.*

The choice of signals on which the delay measurement may be started and terminated is listed in Table 4-2.

The measured delay time interval may range from 0 ms to 9999 ms. If the time elapsed between the signal edges delineating the measurement interval is greater than 9999 ms, an overflow condition will result and "9999 MS" will be displayed. Unless an overflow condition occurs, the display will remain blank until the measurement is completed.

* When "Detection of trap characters" is selected as the end-of-measurement event, no edge selection is necessary.

Table 4-2. Delay Measurement Start and End Signals

<u>Start-of-Measurement</u>	<u>End-of-Measurement</u>
DTR	DTR
DSR	DSR
RTS	RTS
CTS	CTS
CD (RLSD)	CD (RLSD)
Output Data	Receiver Data
Generator Active	Detection of trap characters
Input X	Input Y

Input X and Input Y refer to signals applied by the user to rear panel test points designated "X" and "Y".

4.3.6 Data Trapping

As an alternative to performing error analysis, the DATA SENTRY 10's receiver may be set to trap on up to four characters of the incoming data by selecting the TRAP position of the RCVR FUNCTION switch. The trap characters are user selectable through the "TRAP" position of the DISPLAY/ENTRY switch and may be programmed in 5, 6, 7, or 8 level code.

Upon detection of the programmed trap characters in the incoming data stream, the TRAP DETECT LED is illuminated. A data segment extending from 128 characters before the trap sequence to 128 characters after the trap sequence is stored for subsequent viewing in the display. Alternatively, the first 255 characters received after character synchronization is achieved can be trapped. This data segment is also available for printout.

Section 4.5.1.10 describes the entry of the desired trap characters and the display of the trapped characters.

Data trapping is available in the Asynchronous Timing mode, and with messages in the Synchronous and Recovered Timing modes. Note that the transmitter behaves in the Trap mode identically to the Error Analysis mode.

4.3.7 Real Time Clock

The DATA SENTRY 10 features a real time clock which allows the time (in year, month, day, hours, minutes, and seconds) to be printed with any result or message output. When the unit is disconnected from the AC supply, the real time clock is powered by an internal battery, allowing the correct time to be maintained when the unit is not in use.

4.4 MODES OF OPERATION

The following sections describe the modes of operation of the DATA SENTRY 10. These operating modes are selected by the MODE, TIMING, RCVR FUNCTION, and EMULATE switches.

4.4.1 Full Duplex Mode

The Full Duplex mode is selected by the "FDX" position of the MODE switch. Full Duplex operation is available in all timing modes and at all DATA SENTRY 10 bit rates.

In the Full Duplex mode, the DATA SENTRY 10 continuously and repetitively transmits the pattern or message selected by the DATA switch. Simultaneously, either error analysis or data trapping is performed on the received data, as selected by the RCVR FUNCTION switch. Table 5-1 shows the error analysis results available in the Full Duplex mode.

4.4.2 Single Transmit Mode

The Single Transmit mode is selected by the "SNGL TX" position of the MODE switch. Single Transmit operation is available in all timing modes and at all DATA SENTRY 10 bit rates.

In the Single Transmit mode, data transmission begins after the START/RESTART switch is depressed (assuming

the correct signaling is present), and ends after one complete pseudorandom pattern or message is transmitted (or after one character is transmitted for PREAM ONLY or after 1000 bits have been transmitted for other fixed patterns). No error analysis is performed on the received data in the Single Transmit mode, although data trapping may be performed on character formatted data at data rates below 20 kbps.

4.4.3 Half Duplex Operation

Half Duplex operation is available in the Recovered Timing mode at bit rates from 10 to 9999 bits per second and in the Synchronous and Asynchronous Timing modes at bit rates from 10 to 20,000 bits per second. Half Duplex error analysis and data trapping are available only in the Emulate DTE mode.

In Half Duplex mode, the DATA SENTRY 10 automatically alternates between data transmission and data reception/analysis each time the line to the DCE is turned around. Handshaking between the test set and the DCE and line direction control is accomplished through use of the RTS, CTS, and RLSD signaling leads at the DTE/DCE interface. When the test set has control of the line it will transmit one message or one character for message or preamble only data, or 1000 bits* for pseudorandom patterns, after which it automatically falls into receive mode and relinquishes line control. In the receive mode, the test set expects to receive the same type of data it just transmitted as determined by the setting of the DATA switch. The test set immediately

*The transmitted and received block length for pseudorandom patterns may be made equal to the pattern length instead of 1000 bits by use of Auxiliary Function 24.

synchronizes to the incoming data and begins to provide error analysis results. The action taken by the DATA SENTRY 10 upon reception of the last bit of the incoming data depends on whether it is operating in the Half Duplex Continuous or Half Duplex Single mode of operation.

Several user-selectable time delays are provided to aid in the diagnosis of half duplex system problems. These time delays are discussed in Section 4.4.3.3.

4.4.3.1 Half Duplex Continuous Mode

When the MODE switch is set to "HDX CONT," the test set freezes all error analysis counters upon reception of the last bit of incoming data or when RLSD is dropped and transmits another complete pattern or message. In this manner, the DATA SENTRY 10 continues to alternately transmit and receive with the error analysis counters enabled during each receive period. All error counts are cumulative (i.e., the error counters are not reset each time a new message is received). At any time during the test, the error counters may be cleared and the test restarted by depressing the START/RESTART button on either of the communicating test sets. In the event that a test set fails to achieve synchronization to an incoming pattern or message, the BLOCKS ANALYZED count is not incremented and no error analysis is performed on the data.

4.4.3.2 Half Duplex Single Mode

With the MODE switch set to "HDX SGL", the test set is conditioned to stop the test after one complete transmit-receive cycle. Two test sets are necessary to perform a dynamic half duplex test,

either one of which may be used to initiate the test. Upon depressing the START/RESTART button on one of the test sets, that unit transmits a single pattern or message and then falls into the receive mode. The test set at the other end of the link receives and analyzes the data sent by the first test set and responds by transmitting back the pattern or message chosen for the test. The first unit then receives and analyzes the data sent to it and the test is complete. Each test set holds its error analysis results so that they may be read by the user at any time after the test.

Depressing the START/RESTART button on either unit at any time will cause that unit to reset all of its error counters and transmit another pattern or message. The second test set will analyze the data and display the combined error analysis results for all of the data it has received since its START/RESTART button was depressed, and again respond by sending back the chosen pattern or message. The first test set, having had its error counters cleared, will then display the results of the analysis it performed on the data sent back to it. Both test sets then remain in the Receive mode until directed to further action (i.e., until the START/RESTART button is again depressed on either unit).

In the event that a test set fails to achieve synchronization to an incoming pattern or message, the BLOCKS ANALYZED count is not incremented.

4.4.3.3 Half Duplex Delay Intervals

Several selectable time intervals are provided to aid in the diagnosis of half duplex system problems. The following section describes a typical half duplex

transmission/reception sequence and the available time intervals which are selectable via auxiliary functions.

The sequence in Figure 4-1 starts with the local DTE raising RTS. Some time later, the local modem responds to RTS by turning on CTS, after which the local DTE begins to transmit data. After the transmission is complete, the local DTE drops RTS and finally the local modem drops CTS and the transmission sequence is completed. Once the remote DTE has completed the reception, it will raise its RTS lead (not shown in diagram) and some time later the local modem will detect carrier and raise RLSD. Some time after RLSD is raised, the local modem will begin to provide receive data to the local DTE. After all data has been sent from the remote DTE and it drops RTS, the local modem will detect a loss of carrier and drop RLSD completing the reception sequence.

Time interval T_1 is referred to as the Minimum Transmit Delay, and is set by Auxiliary Function 31. Minimum Transmit Delay is the time between the local DTE raising RTS and the beginning of data transmission. This interval is normally approximately equal to the RTS-to-CTS delay of the modem. This RTS-to-CTS delay, which is usually strappable within the modem, is usually strapped to account for system delays such as the time required to disable echo suppressors and for remote carrier detection. When T_1 is set to zero through Auxiliary Function 31, transmission will start as soon as CTS is raised. If it is set to any other value, transmission will not start until the selected time interval has elapsed and CTS is true. This interval allows the user to investigate the effect of increasing the RTS-to-CTS delay without restrapping the modem. It also

allows him to determine the minimum acceptable RTS-to-CTS delay by strapping out the modem delay and increasing the Minimum Transmit Delay until the system functions properly. This delay is selectable in 1 ms steps between 0 and 999 ms.

Time interval T_2 is referred to as Receive Blanking Interval, and is set by Auxiliary Function 32. When this interval is set to a non-zero value, the DATA SENTRY 10 will ignore RLSD and receive data signals until the interval has expired. This interval is used to make the test set ignore spurious signals caused by reflected echos, which occur on two-wire facilities for up to 100 ms after RTS is turned off. A number of modems provide this type of squelching, and through Auxiliary Function 32, this interval is selectable between 0 and 999 ms in 1 ms steps in the DATA SENTRY 10.

Time interval T_3 is referred to as the Line Turnaround Delay, and is set by Auxiliary Function 33. This selects the time between the DATA SENTRY completing one reception and starting a transmission sequence. This interval is useful for slowing down the entire line turnaround cycle.

4.4.4 Self Loop Mode

The Self Loop mode is selected by the "SELF LOOP" position of the MODE switch. When the DATA SENTRY 10 is placed in the Self Loop mode, the outputs of the clock and data line drivers are looped back to the inputs of the clock and data receivers on the installed Data Interface. This operation completely isolates the clock and data drivers and receivers from the interface connector,

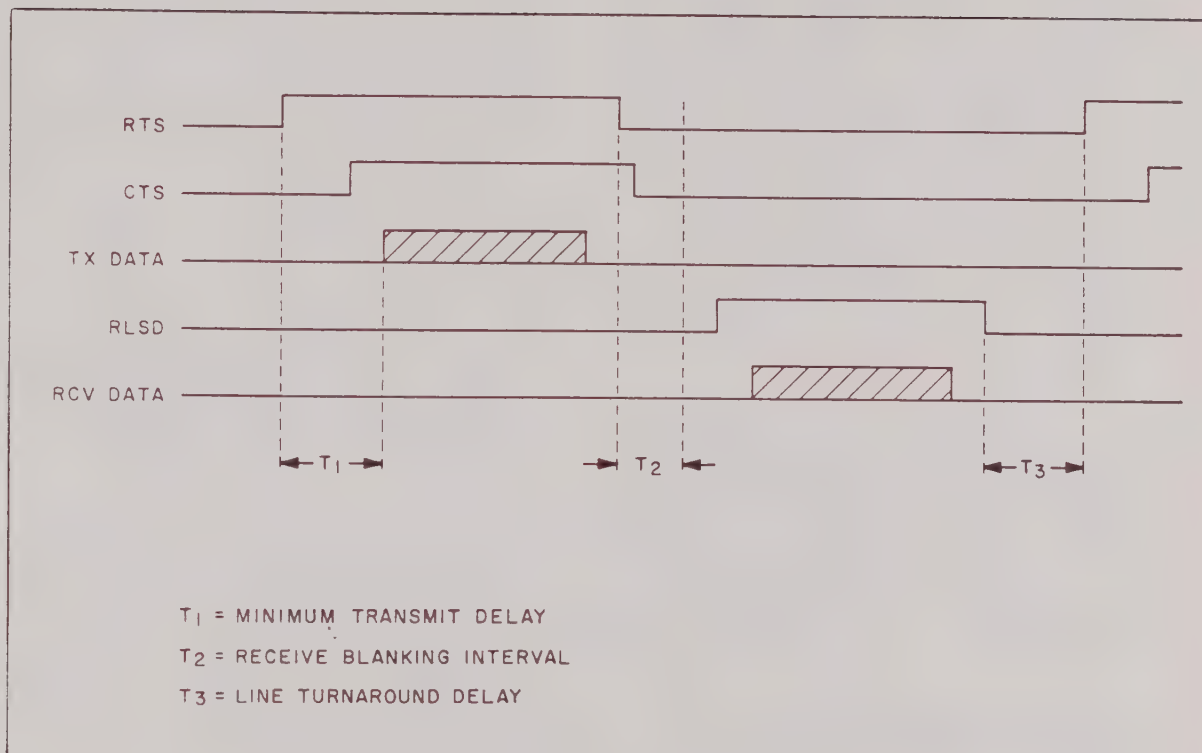


Figure 4-1
HALF DUPLEX CONTROL SEQUENCE SHOWING TIME DELAYS

allowing Self Loop testing to be performed without disconnecting the DATA SENTRY 10 from the system under test. The Self Loop mode is useful for verifying proper instrument setup and operation as well as for checking operation of the installed Data Interface at the selected data rate. Data is continuously transmitted and received in this mode regardless of the states of any interface signaling leads. There is no inherent operating speed restriction associated with the use of the Self Loop mode. Available error analysis results are exactly the same as for the Full Duplex mode and hence the triangular "FDX" indicator above the DISPLAY I switch is illuminated when the Self Loop mode is chosen.

Note: For proper Self Loop operation, Auxiliary Functions 12 and 13 must be set to select primary channel operation for both transmission and reception. Also, Auxiliary Function 07 (Receive Data Invert) must be set to OFF unless Auxiliary Function 06 (Generator Data Invert) is also ON.

4.4.5 Synchronous Timing Mode

The Synchronous Timing mode is selected by the "SYNC" position of the TIMING switch. Synchronous timing may be selected for messages and Half Duplex operation at bit rates from 10 to 20,000 bits per second and for patterns at any bit rate.

When the Synchronous Timing mode is selected, data is transmitted with an accompanying clock signal, and the DATA SENTRY 10 expects a clock signal to accompany the received data. In the Emulate DTE mode, a clock signal is expected on the Receive Clock interface

lead. (See Figure 4-2). In the Emulate DCE mode, the DATA SENTRY 10 uses an automatic selection scheme to select its receiver clock. A clock signal normally accompanies the data on the Transmit Clock (DTE Source) line, and the test set first checks for the presence of a signal on this lead. If there is no signal present, the test set automatically takes its receiver clock from the Transmit Clock (DCE Source) line, driven by the test set itself. Auxiliary Function 22 can be used to override the automatic clock selection.

4.4.6 Asynchronous Timing Mode

The Asynchronous Timing mode is selected by the "ASYNC" position of the TIMING switch. Asynchronous operation is limited to bit rates from 10 to 20,000 bits per second.

In the Asynchronous Timing mode, all data is formatted into characters, with start and stop bits. (Section 4.2.4 describes the character format). In normal operation, no clock is transmitted with the data and no clock is expected to accompany the received data.

Auxiliary Function 15 allows the user to place the test set in the 1x Asynchronous Timing mode. In this mode, a clock signal does accompany the transmitted data and a clock is expected with the received data. This mode can be thought of as a hybrid of the Synchronous Timing mode (a clock accompanies the data) and the Asynchronous Timing mode (the data is in character format with start and stop bits). Note that 1 1/2 stop bits may not be selected in this mode.

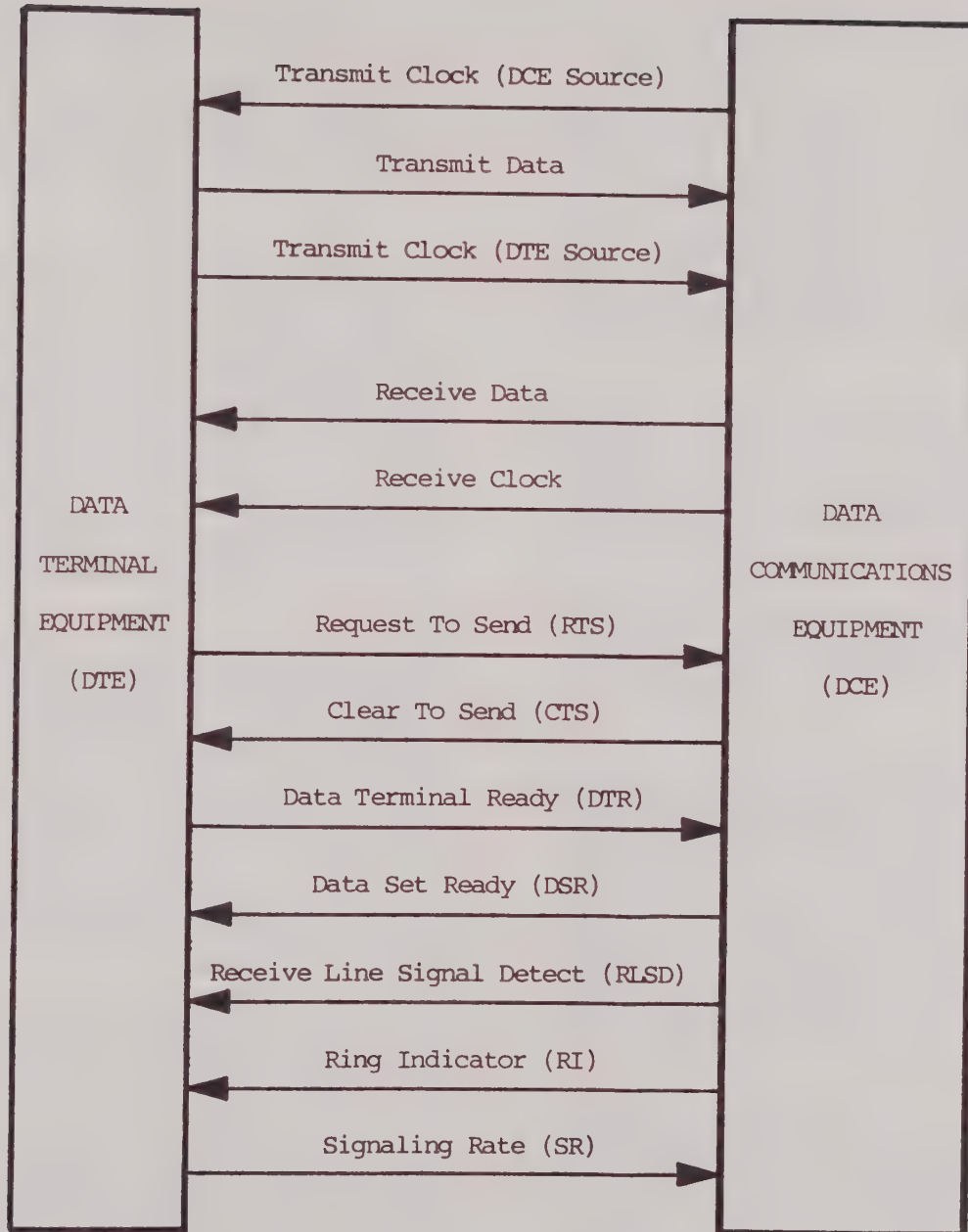


Figure 4-2. Typical DTE to DCE Interface

4.4.7 Recovered Timing Mode

The Recovered Timing mode is selected by the "RECOVD" position of the TIMING switch. Recovered timing in the Half Duplex mode is restricted to the 10 to 9999 bits per second range, and messages are limited to the 10 to 20,000 bits per second range; for patterns in other operating modes, recovered timing is available for 10 to 500,000 bits per second.

When the Recovered Timing mode is selected, data is transmitted with an accompanying clock signal, just as in the Synchronous Timing mode. However, no clock signal is expected to accompany the received data. The DATA SENTRY 10 uses the received data Mark-to-Space and Space-to-Mark transition information to generate (recover) a clock signal that is phase-locked to the received data.

The user must key in the expected received bit rate in the Recovered Timing mode, and the actual received data rate must be within 1% of the selected rate.

Sufficient Mark-to-Space and Space-to-Mark transition density must be maintained to keep the recovered clock phase-locked to the data (e.g., data dropouts may cause clock slips).

4.4.8 Emulate DTE and Emulate DCE Modes

Figure 4-2 shows a typical interface between two devices. One is labeled "Data Terminal Equipment (DTE)" and represents end-user equipment, e.g., terminals, printers, etc. One is labeled "Data Communications Equipment (DCE)" and represents communications devices,

e.g., modems, multiplexers, etc. The figure shows the data, clock, and signaling leads used by these devices to communicate with each other. Note that not all the leads shown are used by all devices; the figure shows only a typical interface.

The DATA SENTRY 10 is capable of communicating with either DTE or DCE devices, through the Emulate DCE or Emulate DTE mode, respectively. In the Emulate DTE mode, the test set acts as (emulates) Data Terminal Equipment and is able to interface with DCE devices. In the Emulate DCE mode, the test set acts as Data Communication Equipment and is able to interface with DTE devices. The front panel EMULATE switch determines the mode of operation.

Most DATA SENTRY 10 Data Interfaces have two connectors, one labeled "TO DTE" and the other labeled "TO DCE." When the test set is operated in the Emulate DTE mode, the system or device under test should be connected to the "TO DCE" Data Interface connector. When the test set is operated in the Emulate DCE mode, the system or device under test should be connected to the "TO DTE" Data Interface connector.

4.4.9 Trap and Analyze Modes

The RCVR FUNCTION switch determines whether the DATA SENTRY 10 will perform data trapping ("TRAP" position) or error analysis ("ANALYZE" position). Section 4.3.6 describes the data trapping capabilities and Section 4.3.1 describes the error analysis capabilities of the test set.

4.5 CONTROLS, INDICATORS, DISPLAYS, AND I/O DESCRIPTION

In this section, the front and rear panel controls, indicators, displays, test points, and connectors are described.

4.5.1 Front Panel

The following sections describe the controls, indicators, and displays found on the front panel of the DATA SENTRY 10. Refer to Figure 4-3 while reading these sections.

4.5.1.1 POWER Switch (1)

The PWR switch is a two position push-button switch with push-on, push-off action. Many LEDs on the front panel will be illuminated when the power is on.

4.5.1.2 DATA Switch (2)

This switch selects the type of data to be transmitted and tells the receiver what type of data to expect. The patterns available are continuous mark (MK), alternating mark/space (1:1), 63, 511, 2047, and 4095 pseudorandom bit patterns (designated by their length), and repeating preamble (PREAM ONLY). In the "PREAM ONLY" position, the last character of the user programmable preamble is sent repetitively. A FOX message may be selected in Baudot, BCDIC, ASCII, or EBCDIC for 5, 6, 7, or 8 bit code levels respectively. Four messages of up to 200 characters long each may be programmed by the user in any code and later recalled for transmission. These user-defined messages are selected by the "USER 1" - "USER 4" positions of the DATA switch.

Note that the continuous mark and 1:1 patterns may not be chosen in Half Duplex operation.

4.5.1.3. MODE Switch (3)

This switch configures the test set's transmitter and receiver to operate in the Full Duplex, Single Transmit, Half Duplex (Single or Continuous) or Self Loop mode.

In the Full Duplex mode, data is continuously and simultaneously transmitted and received. Error analysis or data trapping is performed on incoming data.

In the Single Transmit mode, the pattern or message selected by the DATA switch is transmitted once each time the START/RESTART button is depressed.

The Half Duplex modes provide dynamic half duplex (or ping pong) testing with alternate transmission and reception of data. Signaling control for line turn-around is automatically handled by the test set. In the "HDX SNGL" mode, testing stops after a single transmission-reception cycle, whereas in the "HDX CONT" mode it continues indefinitely.

With the MODE switch in the "SELF LOOP" position, the test set operates in the Full Duplex mode with the transmitter's outputs looped back to the receiver's inputs. This allows the user to perform a manual self test of the instrument by forcing errors in the transmitted data using the ERROR INSERT switch. When in the Self Loop mode, the red "SELF LOOP" indicator will be illuminated to warn the operator that he is not performing a system test.



4.5.1.4 TIMING Switch (4)

This switch is used to determine the timing mode used in both the generator and receiver sections of the instrument. The user is given the choice of Synchronous, Asynchronous, or Recovered Timing modes.

In the Synchronous mode, a clock signal is sent synchronously with the data leaving the Data Interface and a clock signal is expected with the data returned to the Data Interface. The instrument is capable of working at data rates from 10 bps to 500 kbps in the Synchronous mode.

In the normal (16x) Asynchronous Timing mode, data is transmitted and received in character format. No clock is sent or expected; data transmission and reception are handled by a USART utilizing a clock signal at 16 times the data rate. The instrument is capable of working at baud rates from 10 bps to 20 kbps in this mode.

In the auxiliary (1x) Asynchronous mode, data is transmitted and received in character format with start and stop bits. A clock signal is sent with the data leaving the Data Interface and a clock signal is expected with the data returned to the Data Interface. The instrument is capable of working at baud rates from 10 bps to 20 kbps in this mode.

In the Recovered timing mode, a clock is sent synchronously with the data leaving the Data Interface. No clock signal is expected with the data returned to the Data Interface; receiver timing is regenerated from the received data transitions. The DATA SENTRY 10 is capable of working at data rates from 10 bps to 500 kbps in the Recovered Timing mode.

4.5.1.5 GEN CLK Switch (5)

This switch is used to select the source of the generator timing for the instrument. Any one of three sources are selectable for use as a generator clock. If there is no clock signal present at the selected source, a red LED within the switch will be illuminated.

The generator clock may be provided through the rear panel External Clock Input BNC connector. In the Synchronous, Recovered, and auxiliary (1x) Asynchronous Timing modes, the input clock frequency should be at the desired data rate. In the normal (16x) Asynchronous Timing mode, the input clock frequency should be 16 times the desired data rate.

The generator clock may be obtained directly from the Data Interface in certain timing modes. See Section 5.3.3 for Data Interface clock sources and restrictions.

The third selectable generator clock source is the internal frequency synthesizer. The frequency synthesizer is capable of generating frequencies from 10 Hz to 500 kHz in the Synchronous and Recovered timing modes and is capable of generating 16x clock frequencies for Asynchronous data rates from 10 bps to 20 kbps. User access to the frequency synthesizer is provided through the keyboard.

4.5.1.6 CODE LEVEL Switch (6)

This switch sets the number of information bits per character for all data that is in character format. All Asynchronous data as well as messages transmitted in the Synchronous and

Recovered timing modes are character formatted. The number of information bits per character can be set to 5, 6, 7, or 8.

4.5.1.7 PARITY Switch (7)

Selects odd, even, or no parity for all data that is in character format.

4.5.1.8 STOP BITS Switch (8)

Selects the number of stop bits per character in the Asynchronous timing mode.

4.5.1.9 BER INTERVAL Switch (9)

Determines the number of incoming data bits over which bit error rate is measured.

4.5.1.10 Keyboard, Left-Most Display, DISPLAY/ENTRY Select Switch (10, 11)

4.5.1.10.1 Introduction

The DATA SENTRY 10's 20-key keyboard allows simple and straightforward entry of numeric information and hexadecimal code characters. In conjunction with the 8-character left-most display, the keyboard also facilitates the entry of user selectable nonnumeric parameters such as the specific signal edges between which the delay measurement is made and the ON or OFF condition of the transmit data inverter. Many functions not frequently used may be accessed through the keyboard as auxiliary functions.

The specific keyboard entry mode is determined by the setting of the seven position DISPLAY/ENTRY switch. Due to the varied nature of the information that is entered in the different modes, each mode has a unique keyboard entry procedure. This section describes these entry procedures in detail.

4.5.1.10.2 Synthesizer Frequency and Receiver Frequency Entry

In normal operation, the synthesizer frequency and receiver frequency are the same.

To facilitate changing the value of both of these parameters at the same time, the "SYNTH FREQ" and "RCVR FREQ" positions of the DISPLAY/ENTRY switch act as a single position, with both indicator LEDs being illuminated at the same time. Auxiliary Function 14 allows these two parameters to be set independently if split frequency operation is desired.

The desired frequency is keyed in in hertz. Upon entry of the first digit, the display is cleared with only the entered digit remaining. Subsequent digits are added to the display as they are keyed in, the entered information remaining right-hand justified at all times. When the desired frequency is shown in the display, the ENTER key is pressed, completing the operation. Depression of the ENTER key causes the displayed digits to be reformatted if necessary and the "HZ" or "KHZ" designation to appear to the right of the digits, indicating that the selected parameter has been changed to the displayed value.

There are several restrictions upon the entered frequency value. All entered values must be between 10.00 Hz and 500,000 Hz. The display will respond to values outside of this range with the message "TOO HIGH" or "TOO LOW", as appropriate, upon depression of the ENTER key. Also, since the resolution and accuracy of the internal frequency generating circuits extends only to 4 significant figures, all digits keyed in after the fourth digit will be displayed as zeros regardless of which key is depressed. Depression of any digit key other than zero after the fourth digit has been entered will result in an audible beep being generated by the instrument to warn the operator that the entry is being changed.

If an erroneous keystroke is made during the entry of a frequency value, the left arrow key may be used to delete the last digit entered and allow its re-entry. Each time the left arrow key is depressed, the rightmost display digit will be deleted and the resulting display will be right-hand justified. When only a single digit remains in the display and the left arrow key is pressed, the current value of the selected parameter will be restored to the display.

4.5.1.10.3 Delay Measurement Selection

The "DELAY" position of the DISPLAY/ENTRY switch allows the user to use the keyboard to select the specific signal edges between which the delay measurement is made. The display format is:

XXX_YYY_

where XXX is the designation of the signal upon which the measurement starts and YYY is the designation of the signal that terminates the measurement.

Each designation (with the exception of the end-of-measurement event "TRAP") is followed by either "/" or "\" to indicate whether the delay measurement circuitry responds to the rising edge or the falling edge, respectively, of the designated signal.

To change the delay interval to be measured, the right arrow key is depressed. This causes the XXX part of the display to begin flashing. Pressing the SCROLL key causes the start-of-measurement parameter to step through the designations of the 8 signals upon which the delay measurement may be started. Once the designation of the desired signal is showing in the display, the right arrow key is again depressed, causing the start-of-measurement parameter to cease flashing and the signal edge indicator to begin flashing. This indicator can be set to either rising edge (/) or falling edge (\) by depressing the SCROLL key. Once this parameter is correctly set, the end-of-measurement signal and then the corresponding signal edge indicator may be set in a similar manner. When the display indicates the desired measurement, the ENTER key is depressed and all flashing of the display ceases, indicating the completion of the operation.

At any time during the selection of the delay parameters, the left arrow key may be used to allow reselection of the measurement parameter to the left of the one currently flashing. Thus, the left arrow key in conjunction with the right arrow key allows selection of the four delay measurement parameters in any order desired. If the left arrow key is depressed when the start-of-measurement parameter (XXX) is flashing, the end-of-measurement signal edge indicator will begin flashing.

4.5.1.10.4 Preamble Entry

A preamble of up to four characters may be entered in this display/entry mode. Each code character is represented by two hexadecimal characters which are entered directly through the keyboard. A conversion chart from hexadecimal characters to the corresponding 5, 6, 7, and 8 level standard code characters is supplied as Appendix B to this operating manual.

When the "PREAM" position is selected, the current preamble will appear in the display. To change the preamble characters, depress the alphanumeric keys. The entered hex characters are always kept in groups of two, each group representing one code character. Tick marks on the test set's front panel immediately below the left-most display are used to delineate code character boundaries.

Until the preamble entry procedure is completed by pressing the ENTER key, all displayed characters will flash to distinguish these characters from the currently set preamble. At any time during the entry of the new preamble, the left arrow key may be used to allow correction of a previously entered hex character or characters.

Since each preamble code character is represented by two hex characters, the number of hex characters entered should always be even. If an odd number of characters is entered, the last character entered will be dropped. This change will be reflected in the display upon depression of the ENTER key.

If no preamble is desired, the SCROLL key is depressed once and the display will indicate "NO PREAM". Depressing the SCROLL key again will cause the most recently set preamble to be restored to the display, and the transmit and receive circuitry will again be conditioned to operate with this preamble. Thus, the SCROLL key acts as an on-off switch for the preamble. The right arrow key is inactive in the PREAMBLE entry mode.

4.5.1.10.5 Trap Sequence Entry and Trapped Data Display

General

The Trap display/entry mode is unique in that it is the only mode in which the DATA SENTRY 10's left-most display is used to show information received by the test set. Two operations may be performed by the user when the DISPLAY/ENTRY switch is in the "TRAP" position: a trap sequence of 1 to 4 code characters may be programmed into the receiver's trap memory, (or trap on "DATA" may be selected), or the trapped characters may be caused to scroll across the left-most display. Trapped data is also available for printout.

1. Display of Trapped Data

When the RCVR FUNCTION switch is set to "TRAP", the DATA SENTRY 10's receiver will scan the incoming data for the programmed trap sequence. Upon detection of this sequence, the "TRAP DETECTED" indicator will illuminate and the data received on either side of the trap sequence will be available for display. When the DISPLAY/ENTRY switch is set to "TRAP", the hexadecimal representation of the programmed trap

characters will appear in the alphanumeric display, set off by double brackets. By depressing the right arrow or left arrow keys, the displayed characters may be caused to scroll to the right or left, respectively, allowing the user to view the received data on either side of the trap characters. Since each code character is represented by two hex characters, tick marks on the front panel under the left-most display are used to delineate code character boundaries in the displayed trap sequence and data.

The trapped data may be moved left or right by depressing the left arrow or right arrow keys. Depressing and releasing either arrow key causes the displayed characters to move two digits (one code character) in the direction of the arrow. Holding either arrow key depressed for more than one second causes the displayed characters to move in the direction of the arrow at a constant rate until the key is released or the end of trapped data is reached.

The trapped data may be viewed until the START/RESTART button is depressed, which clears the trapped data memory and prepares the unit to perform another trap operation.

Depression of the SCROLL key during the display of trapped data clears trapped data memory and allows the entry of new trap characters.

2. Trap Sequence Entry

When the DISPLAY/ENTRY switch is set to the "TRAP" position, the current trap sequence will be shown whether or not any data has been trapped. If no data has been trapped, no brackets or other

characters will appear around the trap characters. The procedure for entering the hexadecimal representation of the desired new trap sequence is identical to the preamble entry procedure described in Section 4.5.1.10.4.

If instead of trapping on a set sequence of characters it is desired to trap on the first character detected by the receiver, the SCROLL key may be depressed once, causing the displayed trap characters to be replaced by the word "DATA". When Asynchronous timing is employed in this trap mode, the first 255 characters received after the START/RESTART button is depressed will be stored in memory and may be viewed in the same way as other trapped data. For the Synchronous and Recovered timing modes the first 255 characters received after the detection of the programmed SYN characters (see Section 4.6.5.4) will be stored in the trap buffer. In all cases, brackets will appear around the word "DATA" the instant the first character is sent to the trap buffer. Trapped data may be scrolled through the display by using the left arrow key.

The receiver may be placed back in the trap-on-characters mode by again depressing the SCROLL key. This action will cause the previously set trap characters to return to the display but will not cause the unit to perform another data trap operation if it has already trapped on a data transition. In this case, as always, the trap function must be re-initialized by depressing the START/RESTART button.

4.5.1.10.6 Front Panel Program Mode

General

The program feature allows the settings of most of the front panel switches as well as the keyboard selectable parameters to be stored in memory and assigned a single digit program number (0-9) so that they may be recalled at some future time. These programs are retained even when power is removed from the test set.

1. Storing A Program

After all of the front panel switches and keyboard selectable parameters have been set as desired, the entire configuration may be stored in the following manner:

Set the DISPLAY/ENTRY switch to "PROG", then key in the characters "AAA" followed by ENTER. This informs the microprocessor of the user's desire to store a program. The unit will respond by displaying "NUMBER?". The program may be assigned any number between 0 and 9 by keying in the desired number followed by ENTER. Any program previously stored under this number will be overwritten and the display will read "PC/" followed by the entered program number, indicating that the unit is now under program control. Changing the setting of any of the front panel switches other than the DISPLAY/ENTRY switch causes the unit to exit program control mode, and the "PC/" preceding the program number will be replaced by "LAST". This operation will not affect the stored program.

2. Recalling A Program

When the DISPLAY/ENTRY switch is set to "PROG", the most recently selected program number will appear in the rightmost position of the display. If none of the front panel switches (other than the DISPLAY/ENTRY switch) or keyboard selectable parameters have been changed since the unit was last placed under program control, the displayed program number will be preceded by "PC/" indicating that the unit is still under program control. If the test set's configuration has been changed, the display will show the most recently used program number preceded by the word "LAST". To select another program, the number of the new program is keyed in followed by ENTER. Depressing the ENTER key causes the unit to be placed under control of the new program and causes a "PC/" to precede the program number in the display. The left arrow key acts as a "backspace" key in the program display/entry mode, allowing erroneous keystrokes to be corrected. The test set can be caused to exit program control mode at any time by simply resetting any of the front panel switches or keyboard selectable parameters.

4.5.1.10.7 Auxiliary Functions

(See Section 4.6)

4.5.1.11 DISPLAY/ENTRY Switch (11)

(See Section 4.5.1.10)

4.5.1.12 AUX FUNC IN USE Indicator (12)

This LED is illuminated whenever any of Auxiliary Function 01 through 24 or Auxiliary Function 64 are set to a non-normal status. (See Section 4.6)

4.5.1.13 START/RESTART Switch (13)

In all modes of operation depressing the START/RESTART switch causes all accumulated test results, measurement values, and latched indicators to be cleared, and all tests and measurements are restarted. When performing data trapping the START/RESTART switch also serves to clear the trap buffer and re-initialize the trap function. A green LED inside this switch is illuminated whenever the DATA SENTRY 10 is transmitting data through its data interface. The "ON" condition of this indicator is extended for approximately one-half second after data generator turn-off so that even very brief data generator activity is visible.

Additional functions are performed by the START/RESTART switch in the Single Transmit and Half Duplex modes of operation. Depression of the START/RESTART switch in the Single Transmit mode causes a single pattern or message to be transmitted.

In the Half Duplex Single mode, depressing the START/RESTART switch initiates the test by causing the unit to transmit a single pattern or message. The test is complete after the same single pattern or message is received by the test set.

In the Half Duplex Continuous mode, this switch acts as a test start or restart

switch with the ping-pong test continuing indefinitely after the switch is first depressed. Depressing the switch again while the test is in progress causes the error analysis counters to be reset on the unit whose switch was depressed and the Half Duplex control sequence to be restarted.

4.5.1.14. RCVR FUNCTION Switch (14)

This switch instructs the test set's receiver to either perform error analysis on the incoming data or to scan the data for the programmed trap character sequence and perform a trap function.

4.5.1.15. ERROR INSERT Switch (15)

In all operating modes, a momentary depression of this switch forces a single bit error in the transmitted data. In the Full Duplex and Self Loop modes, holding the ERROR INSERT switch down for more than a second causes errors to be continuously inserted in the transmitted data at a 10^{-3} bit error rate. In Half Duplex operation, setting this switch to the " 10^{-3} " position causes one error to be inserted in each transmitted block.

4.5.1.16 EMULATE Switch (16)

This switch determines whether the test set is to emulate Data Terminal Equipment (DTE) or Data Communications Equipment (DCE). The current mode of emulation is indicated by the illumination of one of the two triangular indicators above and below the EMULATE switch.

4.5.1.17 Signaling Controls and Indicators (17)

These switches control the state of the RTS, DTR, and Signaling Rate outputs for DTE Emulate mode, or CTS, RLSD, and DSR for DCE Emulate mode. Signaling is automatically controlled for Half Duplex testing. Generator data is held marking when certain interface leads are not in the appropriate state. The indicator inside each switch is on or off, for the on or off signaling states, respectively.

Status of RLSD, CTS, DSR, and RI is displayed for Emulate DTE mode. Status of RTS, DTR, and Signaling Rate (SR) is displayed for Emulate DCE mode.

RLSD LOST indicator illuminates if RLSD has gone off since the test start in Full Duplex Emulate DTE mode. In Half Duplex operation, this indicator illuminates when RLSD has gone off before one full block of data has been received. In either mode, depressing the switch resets the indicator to the off state.

4.5.1.18 IN SYNC Indicator (18)

When the receiver has achieved proper synchronization with the received data, this LED is illuminated. It will remain illuminated until the received data ceases or until sync is lost as indicated by a very high measured error rate. In the Half Duplex mode, the ON condition of this indicator is time-extended until RLSD is dropped.

4.5.1.19 SYNC LOST Indicator and Indicator Reset (19)

The LED indicator inside this pushbutton switch is illuminated immediately upon the detection of a receiver sync loss and remains illuminated until the button is depressed or the test is manually restarted by means of the START/RESTART button.

4.5.1.20 TRAP DETECT Indicator (20)

The TRAP DETECT indicator serves to inform the operator that the programmed trap characters have been detected when the RCVR FUNCTION switch is set to "TRAP". In this mode, the LED remains illuminated until the START/RESTART button is depressed.

4.5.1.21 Center Display and DISPLAY I Switch (21, 22)

The DISPLAY I switch is used to select which one of the available error analysis results is shown in the center display. For clarity, each switch position carries two labels, one for Full Duplex operation (FDX) and one for Half Duplex operation (HDX). The triangular indicator under the designation corresponding to the current mode of operation (FDX or HDX) is illuminated. For operating modes in which a particular result is not available, the center display will indicate "N/A" when the DISPLAY I switch is set to the position corresponding to that result. The available results are described in this section.

4.5.1.21.1 ERRORS (FDX and HDX)

Number of received bits in error since the beginning of the test.

4.5.1.21.2 BER (FDX only)

Measured bit error rate over a number of bits determined by the setting of the BER INTVL switch. The display format shown in Table 4-2 gives an indication of how many errors were detected in the interval.

4.5.1.21.3 BLOCKS ANALYZED (HDX only)

Number of blocks (complete patterns or messages) since beginning of test to which receiver has properly synchronized and on which error analysis was performed.

4.5.1.21.4 BLOCKS (FDX and HDX)

In Full Duplex mode, the number of complete patterns or messages received since beginning of test; in Half Duplex mode, the number of line turnarounds (RLSD On) since the beginning of the test.

Auxiliary Function 64 may be used to set the block length to any value between 63 and 65,535 bits instead of 1 pattern or message in Full Duplex mode only.

4.5.1.21.5 BLOCK ERRORS (FDX and HDX)

In Full Duplex mode, the number of blocks received since the beginning of the test containing one or more bit errors; in Half

Duplex mode, number of blocks analyzed since the beginning of the test containing one or more bit errors.

4.5.1.21.6 SECONDS (FDX and HDX)

In Full Duplex error analysis operation this count corresponds to the number of seconds since the beginning of the test during which error analysis was actually performed. In Half Duplex Single mode the seconds counter begins at the start of the test (START/RESTART button depressed or RLSD On) and stops at the end of one complete transmit-receive cycle. In all other operating modes, this count indicates elapsed time since the beginning of the test.

4.5.1.21.7 ERROR FREE SECONDS (FDX only)

Number of test seconds during which no errors occurred.

4.5.1.21.8 PREAMBLES MISSED (HDX only)

For Synchronous and Recovered messages, the number of blocks since the beginning of the test in which the SYN characters contain one or more bit errors. For all other modes of operation, the number of blocks since the beginning of the test in which the last character of the preamble contained one or more bit errors.

4.5.1.21.9 CHARACTER ERRORS (FDX and HDX)

Number of characters received since the beginning of the test containing one or more bit errors. Available only for character formatted data.

4.5.1.21.10 CLOCK SLIPS (FDX only)

Number of times that clock and data lost phase synchronization since the beginning of the test. Available in Synchronous and Recovered Timing modes with pseudorandom data.

4.5.1.22 DISPLAY I Switch (22)

(See Section 4.5.1.21)

4.5.1.23 Right Display and DISPLAY II Switch (23, 24)

The DISPLAY II switch allows the user to select one of seven test results or the time for display on the right-hand seven digit alphanumeric display. All of the test results are measured simultaneously, so no measurement delay will be experienced by the user when switching from one result to another. For operating modes in which a particular result is not available, the display will indicate "N/A" when the DISPLAY II switch is set to the position corresponding to that result. When the VF Measurement Module is not installed, "NO OPT" will be displayed when in the "AUDIO FREQ" or "AUDIO LVL" positions of this switch. The results provided are described in this section.

4.5.1.23.1 Telegraph Distortion

Early and late distortion are continuously measured for any type of data in the Full Duplex Asynchronous and Recovered timing modes. The display format is XXE YYL where XX represents the early distortion measurement and YY represents the late distortion measurement.

Results are displayed as percentages of a bit period. The display normally displays the maximum value of distortion over the last two seconds. Every 12 seconds the maximum value since the test start is displayed for two seconds. Two small LED indicators next to the display indicate whether the displayed value is a 2-second maximum or a test maximum.

4.5.1.23.2 Bias Distortion

Bias Distortion is continuously measured in all operating modes. The display format is XXX% MK for distortion toward Mark and XXX% SP for distortion toward Space.

4.5.1.23.3 Delay

The result of the delay measurement is displayed in milliseconds. This result is held until the START/RESTART button is depressed, after which the test set is prepared to make another delay measurement. The events between which the delay is measured may be selected through the keyboard and left-most display.

4.5.1.23.4 Receiver Frequency

The frequency of the clock accompanying the incoming data (for Synchronous and 1x clock Asynchronous mode) or the recovered clock (for Recovered Timing mode) is continuously measured and displayed in hertz. The measurement interval is normally 1 second, but an auxiliary function may be used to select a 10 second or 100 second interval for greater accuracy. In the 16x clock Asynchronous Timing mode, no measurement

is provided and the display indicates "N/A." Special considerations apply to frequency measurements made in Half Duplex operation. See Section 5.3.12.

4.5.1.23.5 Generator Clock Frequency

The frequency of the clock applied to the DATA SENTRY 10's data generator is continuously measured and displayed in hertz. Measurement interval choices are the same as those for receiver frequency. This measurement is available in all timing modes. See also Section 5.3.12.

4.5.1.23.6 Time

Displays hours and minutes from the real time clock in 24-hour format.

4.5.1.24 DISPLAY II Switch (24)

(See Section 4.5.1.23)

4.5.1.25 DISPLAY HOLD Switch (25)

Depressing this switch freezes all results selectable by the DISPLAY I and DISPLAY II switches so that the values of these results at the instant the button was depressed may be viewed one at a time by stepping through the positions of the display switches. While the display hold feature is on, a red LED inside the button is illuminated to warn the operator that the displays are not showing the current results. Depressing the DISPLAY HOLD button a second time returns the two displays to their normal mode of operation.

4.5.1.26 RCVR INPUTS (26)

These four LEDs give an indication of the status of the clock and data present at the DATA SENTRY 10's receiver inputs. The "CLK ACT" indicator is illuminated whenever a clock signal is provided to the test set's error analysis circuitry. Each time a Mark or Space is detected in the incoming data, the corresponding LED is illuminated for the duration of this condition. The "DATA INV" indicator turns on when the data being received by the test set is the logical inversion of what is expected, and the test set's autopolarity circuit has reinverted the data to allow error analysis to be performed on it.

4.5.1.27. TEST MAX/2 SECOND MAX Indicators (27)

These two indicators are used in conjunction with the Telegraph Distortion display. When the "2 SEC MAX" LED is lit, the values displayed are the maximum values of early and late distortion measured over the previous 2-second interval. When the "TEST MAX" LED is lit, the values displayed are the maximum values of early and late distortion measured over the entire length of the test.

4.5.1.28 AUDIO LEVEL Control (28)

This slide potentiometer serves as the volume control for the internal speaker and the rear panel audio output. The internal tone generator and the VF Measurement Module volume levels are both controlled by this potentiometer. As the control is pushed to the right, the volume level increases. As the control is pushed to the left, the volume level decreases; all the way to the left is the "off" position.

4.5.1.29 PRINT EVENT Switch (29)

The PRINT EVENT switch is used to select one of the PRINT EVENT parameters. The "10 MIN," "30 MIN," and "2 HRS" positions will cause the test results to be printed at the end of the indicated time period. The "ERR SEC" position will cause the test results to be printed at the end of every second in which the received data contained an error. In the "ERR SEC" position a print will also be initiated at the end of every hour. The "TEST INTVL" position will cause the test results to be printed upon occurrence of any of the following events: BER cycle, Trap characters detected, or line turnaround cycle in Half Duplex operation.

When no printout is desired, the PRINT EVENT indicator should be moved to the "OFF" position. Leaving the PRINT EVENT switch in the "OFF" position clears the printer buffer. A print may be initiated at any time by pressing either the RESULTS or CONTROLS switch. A print may also be initiated by an external controller.

4.5.1.30 RESULTS PRINT Switch (30)

The RESULTS PRINT switch will cause the current test results to be sent to the print buffer.

4.5.1.31 CONTROLS PRINT Switch (31)

The CONTROLS PRINT switch will cause the current set-up parameters, including most of the auxiliary functions, to be sent to the print buffer.

4.5.1.32 PAPER FEED Switch and Out-Of-Paper Indicator (32)

The PAPER FEED pushbutton switch will cause line feed characters to be sent to the selected printer. An LED located inside the PAPER FEED button will illuminate when the internal printer is out of paper.

4.5.1.33 Paper Indicator (33)

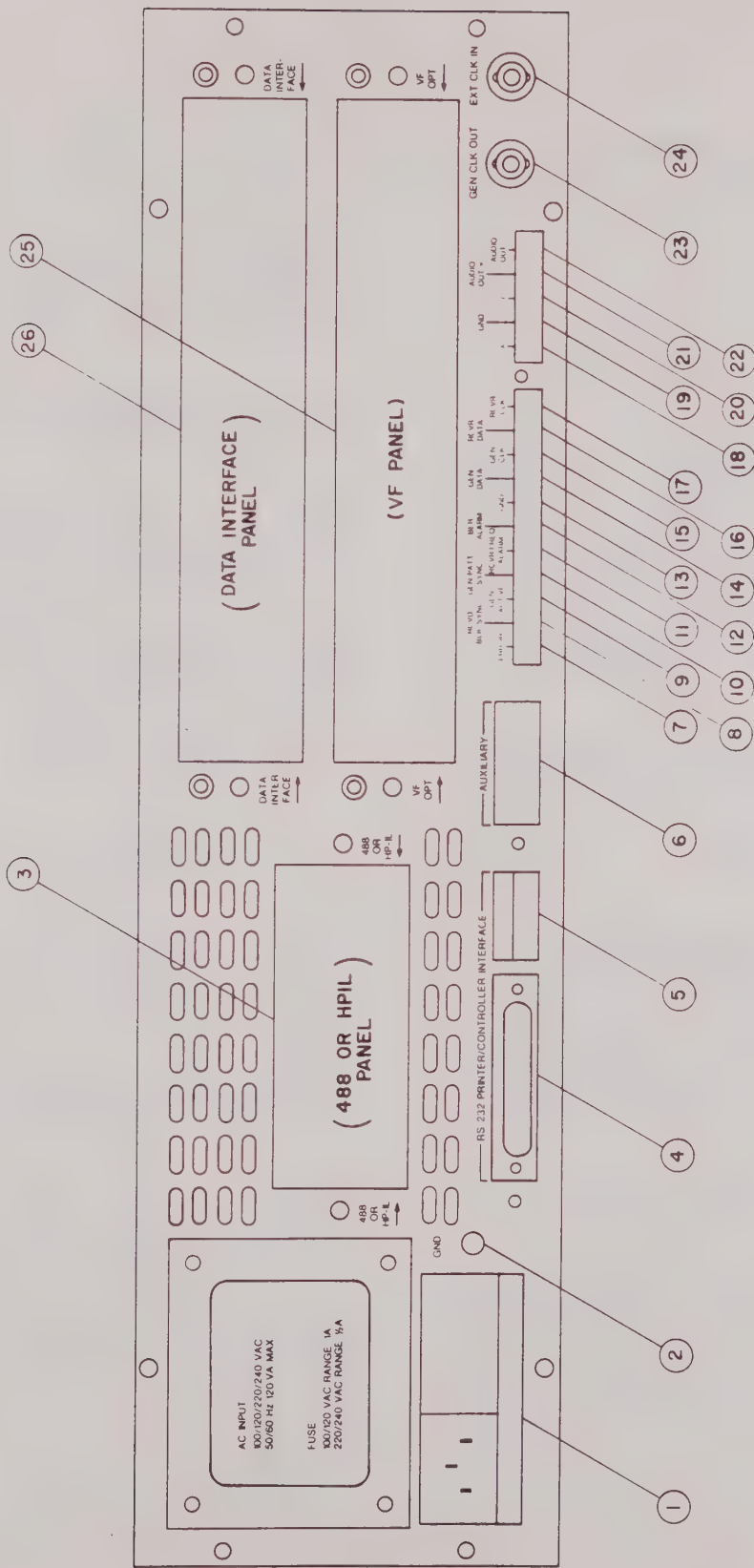
The paper indicator arm displays from Full to Empty the relative amount of paper remaining on the roll.

4.5.1.34. LOCAL and REMOTE Indicators (34)

The "LOCAL" indicator will illuminate when the unit is under control of the front panel. The "REMOTE" indicator will illuminate when the DATA SENTRY 10 is under control of some external device. This device could be connected to either the RS-232, IEEE-488, or the HP-IL interface. The "REMOTE" indicator will remain illuminated until the controller returns control to the front panel. Most front panel switches will have no effect while the "REMOTE" indicator is illuminated. The instrument will always power up in Local mode.

4.5.2 Rear Panel

The following sections describe the connectors and test points found on the rear panel of the DATA SENTRY 10. Refer to Figure 4-4 while reading these sections.



DATA SENTRY 10 REAR PANEL

4.5.2.1 AC Power Input and Voltage Selector (1)

The AC power receptacle accepts a 3-conductor power cable. The center pin of the receptacle is connected to the DATA SENTRY 10 chassis.

////////////////////
 WARNING
The DATA SENTRY 10 chassis should be connected to earth ground. Improperly grounded equipment can present a shock hazard, with hazardous potentials on the instrument.
////////////////////

The voltage selector card is used to select the AC operating voltage and may be set for 100, 120, 220, or 240 VAC. See Section 3.4 for voltage selection and fuse selection information.

 CAUTION
Equipment damage may result from operating the instrument from a voltage other than that selected.

4.5.2.2 GND Screwpost (2)

This screwpost is connected to chassis ground.

4.5.2.3 Remote Control Interface Slot (3)

The optional IEEE-488 or HP-IL Remote Control Interfaces are mounted through this slot. See Section 7 for further information on these Interfaces.

4.5.2.4 RS-232 Printer/Controller Interface (4, 5)

The 25-pin female D-subminiature connector serves as an interface between the DATA SENTRY 10 and an external printer or controller. The DIP switches are used to select the baud rate, parity, etc. of the RS-232 interface. See Section 7 for further information.

4.5.2.5 DIP Switches (5)

(See Section 4.5.2.4).

4.5.2.6 AUXILIARY (6)

Reserved for TTC use.

4.5.2.7 ERROR Test Point (7)

This TTL level output provides a high-going pulse lasting for half of a bit period each time an error is detected in the incoming data. This signal is provided only for pattern data in the Self Loop, Single Transmit, and Full Duplex modes, using Synchronous and Recovered timing.

4.5.2.8 RCVD BLK SYNC Test Point (8)

This TTL level output provides one pulse per block of received data. This pulse is provided in Full Duplex Synchronous and Recovered Timing modes with non-message data.

4.5.2.9 GEN ACTIVE Test Point (9)

This TTL level output is at a logic high level whenever data is being generated by the instrument.

This test point is particularly useful in the Half Duplex mode. The front panel LED inside the START/RESTART switch is illuminated whenever this test point is at a high level.

4.5.2.10 GEN PATT SYNC Test Point (10)

This TTL level output provides one pulse per generated pattern or message. When the DATA switch is in the "PREAMBLE ONLY" position, one pulse is provided per preamble repetition. This pulse is provided in Full Duplex Synchronous and Recovered Timing modes with non-message data.

4.5.2.11 RCVR FREQ ALARM Test Point (11)

This TTL level output provides a logic low whenever the measured receiver clock frequency falls outside a user-defined frequency window. Through Auxiliary Functions 36 and 37, low and high frequency limits may be specified. Whenever the receiver clock frequency falls within the frequency window, the

output provides a logic high level. This test point is driven by an open-collector gate having a 300 mA sink current capability connected to a high value pullup resistor.

4.5.2.12 BER ALARM Test Point (12)

This TTL level output goes to a logic low whenever the current Bit Error Rate (BER) exceeds the value entered through Auxiliary Function 62 (See Section 4.6.5.2). At all other times, the output is at a logic high. This test point is driven by an open-collector gate having a 300 mA sink current capability connected to a high value pullup resistor.

4.5.2.13 GND Test Point (13)

This test point is connected to circuit ground.

4.5.2.14 GEN DATA Test Point (14)

This TTL level output is a buffered version of the generator data sent to the Data Interface. A TTL high level represents a Mark at the Data Interface.

4.5.2.15 GEN CLK Test Point (15)

This TTL level output is a buffered version of the clock used by the generator section of the instruments. This output is directly connected to the GEN CLK OUT rear panel BNC connector (23), and is capable of driving a 50 ohm load.

Depending on the setting of the front panel GEN CLK switch, the source of this clock signal may be the Data Interface, the internal frequency synthesizer, or the EXT CLK IN rear panel BNC connector.

4.5.2.16 RCVR DATA Test Point (16)

This TTL level output is a buffered version of the received data returned from the Data Interface. An all-Mark received pattern will appear as a logic high at the output.

4.5.2.17 RCVR CLK Test Point (17)

This TTL level output is a buffered version of the clock used by the receiver section of the instrument. In the Synchronous and 1x Asynchronous mode, the clock received from the Data Interface is buffered and sent to the rear panel output. In the Recovered Timing mode, the clock generated by the clock recovery system is buffered and sent to the rear panel output. In the normal (16x) Asynchronous Timing mode, the 16x clock used by the USART is buffered and sent to the rear panel output.

4.5.2.18 "X" Input Test Point (18)

This TTL level input is directed to the delay measurement circuitry and may be selected as a start-of-measurement signal.

4.5.2.19 GND Test Point (19)

This test point is connected to circuit ground.

4.5.2.20 "Y" Input Test Point (20)

This TTL level input is directed to the delay measurement circuitry and may be selected as an end-of-measurement signal.

4.5.2.21 AUDIO OUT + and AUDIO OUT - Test Points (21, 22)

This pair of test points provides the DATA SENTRY 10 audio amplifier's output, and may be used to drive an external loudspeaker. The internal loudspeaker and these test points are driven in parallel, and the front panel AUDIO LEVEL control affects both.

CAUTION

Do not use an external speaker rated at less than 8-ohms impedance.

4.5.2.22 AUDIO OUT - Test Point (22)

(See Section 4.5.2.21).

4.5.2.23 GEN CLK OUT BNC Connector (23)

This 50-ohm TTL level output is a buffered version of the clock used by the generator section of the instrument. This output is connected directly to the GEN CLK test point (15).

4.5.2.24 EXT CLK IN BNC Connector (24)

Clock signals applied to this input may be selected for use by the generator timing circuitry. This BNC input accepts a single-ended signal and provides a high impedance load. The use of an external termination (e.g. 50 ohms) is recommended.

Clock signals input through this connector should have a frequency equal to the desired bit rate in the Synchronous, Recovered, and 1x Asynchronous Timing modes. When in the normal (16x) Asynchronous Timing mode, the clock signal should be at 16 times the desired baud rate.

4.5.2.25 VF Module Slot (25)

The VF Measurement Module is mounted through this slot. See Section 10 for further information about this option.

4.5.2.26 Data Interface Slot (26)

The Data Interfaces (RS-232, V.35, etc.) mount through this slot. See Section 8 for further information about these Data Interfaces.

4.6 AUXILIARY FUNCTIONS

4.6.1 Introduction

Selection of this display/entry mode allows the user to access through the keyboard a number of functions which are not controllable by front panel switches. An auxiliary function is accessed by setting the DISPLAY/ENTRY switch to "AUX" and then keying in the function's 2 digit access code followed by ENTER. Upon depression of the ENTER key, the DATA SENTRY 10 will return the alphabetic abbreviation of the selected function to the display as a confirmation to the user that the desired function has been accessed. The action taken at this point depends upon the specific function selected. There are five basic types of auxiliary functions:

1. Status select functions
2. Short data entry functions
3. Long data entry functions
4. Special functions
5. VF Measurement Selection

Each function category has its own specific entry procedure, with the exception of the special functions category, into which fall all of the functions which do not fit any of the other four groups. The special functions, therefore, each have their own unique entry procedure. In this section all of the auxiliary functions are listed (divided into the five categories) and the entry procedure for each type of function is described.

4.6.2 Status Select Functions

Falling into this category are functions which offer a limited number of discrete choices concerning the value of a parameter or the status of a particular circuit within the DATA SENTRY 10. Upon entry of the access code of a status select function, the display will show the function abbreviation (left-hand justified) as well as the current value or status (right-hand justified). By repeatedly depressing the SCROLL key, the user may step through all of the available status choices, with the function abbreviation always remaining at the left hand side of the display. Whenever the display is showing a status choice other than that which is currently set, the status designation will flash. In order to set a new status, the user need only depress the SCROLL key until the desired status is showing in the display and then press the ENTER key. This action will cause the displayed status to be set, and the status designation will cease flashing.

A list of the available status select functions and their corresponding access codes, function abbreviations, and status choices appear in Table 4-3.

In all cases, the status choice listed first is the normal status of the corresponding function. A status select function is declared "in use" when it is set to any status other than its normal status. Whenever one or more status select functions are in use, the "AUX FUNC IN USE" LED is illuminated to warn the operator of this condition. This warning is provided regardless of the setting of the DISPLAY/ENTRY switch.

The user may instruct the DATA SENTRY 10 to automatically display all of the "in use" functions along with their current status selections by setting the DISPLAY/ENTRY switch to the "AUX" position and entering the access code "00." When this is done, the test set will display in turn the abbreviation of each function then in use along with its status. If no status select functions are in use, the alphanumeric display will indicate "NONE".

This automatic scrolling through the "in use" auxiliary functions may be temporarily halted at any time by depressing the SCROLL key. The display will continue to show the function and status that was being displayed at the instant the SCROLL key was depressed until this key is released. As with the auxiliary functions, this special display mode may be exited at any time by depressing and holding the ENTER key or changing the setting of the DISPLAY/ENTRY switch.

A provision is made to allow the user at any time to simultaneously reset all "in use" auxiliary functions to their normal states. This may be done by keying in access code "99" followed by ENTER. Upon taking this action, the "AUX FUNC IN USE" LED will be immediately extinguished. Auxiliary Functions 01 through 24 and Auxiliary Function 64 are affected by this reset function.

4.6.3 Short Data Entry Functions

These functions involve the entry of data sequences short enough to be displayed alongside the function's alphabetic abbreviation. Upon keying in the function's access code and depressing ENTER, the display will show the function abbreviation (left-hand justified) and the current value (right-hand justified). As

Table 4-3. Status Select Functions

<u>FUNCTION</u>	<u>ACCESS CODE</u>	<u>FUNCTION ABBREV.</u>	<u>STATUS CHOICE ABBREV. & DESCRIP.</u>
VF Module Audio Monitor	01	AM	ON-VF Measurement Module audio monitor circuit active and controllable by front panel AUDIO LEVEL pot. OFF-VF Measurement Module audio monitor circuit disabled.
Beeper Activity	02	BEEP	ON-Beeper enabled. Volume controllable by front panel AUDIO LEVEL pot. OFF-Beeper disabled.
Autosync (FDX only)	03	AUTO	ON-Autosync circuit enabled. OFF-Autosync circuit disabled.
Print on Signaling Change	04	PSIG	OFF-Printouts occur only as determined by setting of PRINT EVENT switch. ON-Printouts occur upon a detected ON-OFF or OFF-ON transistion on any supported interface signaling lead in addition to the event selected by the PRINT EVENT switch.
Automatic Display Hold (FDX only)	05	DH	OFF-Manual display hold only. ON-Automatic display hold after first BER interval. Results are held until the DISPLAY HOLD button is depressed.
Generator Data Inverter	06	GINV	OFF-Transmitted data not inverted. ON-Transmitted data inverted.

Table 4-3 (Continued)

<u>FUNCTION</u>	<u>ACCESS CODE</u>	<u>FUNCTION ABBREV.</u>	<u>STATUS CHOICE ABBREV. & DESCRIP.</u>
Receiver Data Inverter	07	RINV	OFF-Received data inversion controlled by autopolarity circuit. ON-Received data inverted before application to receiver circuitry and autopolarity circuit disabled.
Signaling Override (Full Duplex and Single Transmit Only)	08	SO	OFF-Proper signaling lead status required for data transmission/analysis. ON-Data transmission/analysis occurs regardless of state of signaling leads.
In-band Flow Control (Full Duplex and Single Transmit Asynchronous Messages only)	09	FLOW	OFF-Test set does not respond to XON and XOFF characters and in received data. ON-Test set scans incoming data for XON and XOFF characters and responds accordingly.
Short Print Format	10	SPRT	OFF-Results print consists of all available test results. ON-Results print is in an abbreviated format in which only the most commonly used test results are printed.
Printer Select	11	PRT	NORM-Internal and/or external RS-232 printer selected as determined by Table 7-1. INT-Internal printer only selected. 232-External RS-232 printer only selected. REM-External IEEE-488 or HP-IL printer only selected.

Table 4-3 (Continued)

<u>FUNCTION</u>	<u>ACCESS CODE</u>	<u>FUNCTION ABBREV.</u>	<u>STATUS CHOICE ABBREV. & DESCRIP.</u>
Transmit Channel Select	12	TCH	PRI-Selects primary interface channel for data originating at DTE. SEC-Selects secondary interface channel for data originating at DTE.
Receive Channel Select	13	RCH	PRI-Selects primary interface channel for data originating at DCE. SEC-Selects secondary interface channel for data originating at DCE.
Frequency Entry Mode	14	FREQ	COM-Synthesizer and Receiver operate at a common frequency and the corresponding positions of the DISPLAY/ENTRY switch act as a single position. SPL-Synthesizer and Receiver frequencies may be set independently for split frequency operation.
Asynchronous Clock Frequency (Asynchronous timing only)	15	ASYN	16X-External generator clock input must be at 16 times desired data rate. No clocks accompany the transmitted or received data.
Asynchronous Clock Frequency (Continued)			1X-External generator clock input input must be at desired data rate. Outgoing data is and incoming data must be accompanied by a bit synchronized clock (at the data rate).
Receiver Action Upon Sync Loss (FDX only)	16	S/L	CLR-Clear all results counters and and restart test as soon as sync is reacquired. CONT-Continue to accumulate error analysis results while receiver is trying to resynchronize. HALT-Freeze all results counters for duration of sync loss. Test continues as soon as sync is reacquired.

Table 4-3 (Continued)

<u>FUNCTION</u>	<u>ACCESS CODE</u>	<u>FUNCTION ABBREV.</u>	<u>STATUS CHOICE ABBREV. & DESCRIP.</u>
Trap Select	17	TRAP	CHR-Trap data upon detection of currently programmed trap sequence. SIG-Trap occurs upon a detected state transition on the DSR, CTS, or RLSD signaling leads in DTE emulate mode, and on the DTR, RTS, or RLSD signaling leads in DCE emulate mode.
Clock Frequency Measurement Interval	18	FMI	1S-Receiver and generator clock frequencies measured over a 1 second interval. 10S-Receiver and generator clock frequencies measured over a 10 second interval. 100S-Receiver and generator clock frequencies measured over a 100 second interval second interval.
CTS Control (FDX only)	19	CTS	DCE-Test set responds to state of CTS signaling lead as provided by DCE. Note that CTS is either received (Emulate DTE) or controlled (Emulate DCE) by the test set. ON-Test set ignores actual CTS state and responds as if CTS were ON. OFF-Test set ignores actual CTS state and responds as if CTS were OFF.
DSR Control (FDX only)	20	DSR	DCE-Test set responds to state of DSR signaling lead as provided by DCE. ON-Test set ignores actual DSR state and responds as if DSR were ON.

Table 4-3 (Continued)

<u>FUNCTION</u>	<u>ACCESS CODE</u>	<u>FUNCTION ABBREV.</u>	<u>STATUS CHOICE ABBREV. & DESCRIP.</u>
			OFF-Test set ignores actual DSR state and responds as if DSR were OFF.
DTR Control (FDX only)	21	DTR	DTE-Test set responds to state of DTR signaling lead as provided by DTE. Note that DTR is either received (Emulate DCE) or controlled (Emulate DTE) by the test set.
			ON-Test set ignores actual DTR state and responds as if DTR were ON.
			OFF-Test set ignores actual DTR state and responds as if DTR were OFF.
Receiver Clock Select (Emulate DCE only)	22	RCS	AUTO-DCE source transmit timing automatically chosen if DTE source transmit timing is not present at the interface.
			DCE-DCE source transmit timing chosen, overriding auto selection.
			DTE-DTE source transmit timing chosen, overriding auto selection.
Telegraph Distortion Measurement Select	23	DIST	PK-Selects Peak Distortion measurement. Early & Late Distortion is measured on all data transitions.
			JTR-Selects Jitter Distortion measurement. Early & Late Distortion is measured on Space-to-Mark transitions only.

Table 4-3 (Continued)

<u>FUNCTION</u>	<u>ACCESS CODE</u>	<u>FUNCTION ABBREV.</u>	<u>STATUS CHOICE ABBREV. & DESCRIP.</u>
TREND 1-9-1 Compatibility Select (HDX ONLY)	24	191C	OFF-Transmitted and received block length is equal to 1000 bits in pseudo-random patterns. ON-Transmitted and received block length is equal to the pattern length.

the new value is being keyed in, the entered digits will flash to indicate the fact that the displayed value is not the currently set value. Flashing of the entered digits will cease upon depression of the ENTER key. The left arrow key may be used to correct any erroneous keystrokes made during the entry of the new value.

A list of the short data entry functions and their corresponding access codes, function abbreviations and allowable values appears in Table 4-4.

4.6.4 Long Data Entry Functions

The only functions falling into this category are the user defined message entries. Each of the four messages has been assigned a separate access code, but all are displayed and programmed identically. When the access code is keyed in and ENTER is depressed, the hexadecimal representation of the first four characters of the current message is displayed. The right arrow and left arrow keys may be used to cause the displayed message to scroll to the right or left, respectively, allowing the entire message to be viewed by the user. As with the display of trapped data, depressing and releasing either arrow key causes the displayed characters to shift two digits in the appropriate direction, whereas holding either arrow key depressed for more than one second causes the displayed data to scroll across the alphanumeric display at a fixed rate until the key is released or the end of the trapped data is reached. In this display mode, the tick marks on the front panel directly beneath the alphanumeric display delineate code character boundaries.

A new message may be substituted for the one currently programmed through a character-by-character edit process. This gives the user the freedom to modify the current message without requiring a complete re-entry of the data. The procedure is as follows: Using the right and left arrow keys, the first message character to be changed should be placed in the seventh and eighth digit positions of the alphanumeric display. This right-most character position of the display acts as the "edit window." Upon keying in any hexadecimal digit, the eighth display position is blanked and the entered digit appears, flashing, in the seventh position. The next digit entered will be shown in the eighth position of the display with both entered digits flashing to indicate that the entry procedure is still in progress and that the old message character has not yet been overwritten in memory. Depressing the ENTER key will cause the entered digits to cease flashing and terminate the entry procedure. Also upon depression of ENTER, all displayed digits are shifted two positions to the left so that the next message character is showing in the edit window. By repeating the described process, any or all of the current message characters may be changed. After the last character of the current message is changed, the displayed digits will shift two positions to the left leaving the seventh and eighth display positions blank to allow the entry of additional characters. Each user message may contain up to 200 characters.

The SCROLL key may be used to truncate all message characters to the right of the displayed characters at any time. To terminate an edit session depression of the ENTER key is required.

Table 4-4. Short Data Entry Functions

<u>FUNCTION</u>	<u>ACCESS CODE</u>	<u>FUNCTION ABBREV.</u>	<u>STATUS CHOICE ABBREV. & DESCRIP.</u>
Half Duplex Delay Interval T ₁ (Minimum Transmit Delay)	31	T1	0-999: Sets the delay interval in milliseconds.
Half Duplex Delay Interval T ₂ (Receive Blanking Interval)	32	T2	0-999: Sets the delay interval in milliseconds.
Half Duplex Delay Interval T ₃ (Line Turnaround Delay)	33	T3	0-999: Sets the delay interval in milliseconds.
XON Character	34	XON	00-FF: Sets value of XON character for in-band flow control. Enter in hexadecimal.
XOFF Character	35	XOFF	00-FF: Sets value of XOFF character for in-band flow control. Enter in hexadecimal.
Lower Receiver Frequency Alarm Threshold	36	L	10.00-500000: Sets receiver fre- quency in hertz below which Receiver Frequency Alarm output goes active.
Upper Receiver Frequency Alarm Threshold	37	U	10.00-500000: Sets receiver fre- quency in hertz above which Receiver Frequency Alarm output goes active.

When a user-defined message is entered or edited, only the hexadecimal representation of the message characters is stored in memory. Thus, the user must set the CODE LEVEL switch to the desired position each time a userdefined message is selected for transmission. The user has the freedom to select any code level, although it is generally not very useful to transmit a message in a different code level from that in which it was initially programmed.

The access codes for the 4 user defined messages are:

USER 1 41
USER 2 42
USER 3 43
USER 4 44

4.6.5 Special Functions

This category comprises all auxiliary functions that cannot be classified as status select, short data entry, long data entry, or VF Measurement functions. Due to the varied nature of the functions in this category, each of the special functions has its own unique entry procedure. These functions are described in the following sections.

4.6.5.1 Real Time Clock Set

(Access Code 60): This auxiliary function allows the time and date to be set through the keyboard. Upon entry of the access code, the left hand left-most display will show "HH:MM:00" with the letters "HH" flashing, indicating that the clock is in the hours set mode and allowing a two-digit hours figure to be entered (in 24 hour format). Entered digits will replace

the "HH" designation and will flash until the right arrow key or the ENTER key is depressed. Depressing the right arrow key will allow the minutes to be set in a similar manner, and depressing this key again will cause the display to show "DD:MM:YY" with "DD" flashing to indicate that the clock is in the day set mode. Day, month, and year may then be set in a similar manner to hours and minutes, with all entered digits flashing until the right arrow or the ENTER key is depressed.

The time/date entry procedure is set up in such a way that the user need only set those particular parameters that need to be changed from their current values. The user may forego the setting of any parameter that does not need to be changed by simply using the right arrow key to "step over" the letter designation of that parameter. After all desired changes have been made to the time and date parameters, a single depression of the ENTER key will cause all of the set values to be stored in memory, and the TIME position of the right hand display as well as all printed times and dates will reflect the changes.

A provision is made to allow accurate synchronization of the DATA SENTRY 10's real time clock to another time source. The first depression of the ENTER key after the minutes parameter has been set will cause the real time clock to be immediately set to the entered time, with the seconds count starting at zero. Note that this resynchronization of the seconds count will not occur if only the hours parameter has been set.

4.6.5.2 BER Alarm Threshold

(Access Code 62): When the DATA SENTRY 10 measures a bit error rate on the incoming data equal to or exceeding the value set by the user through this auxiliary function, a TTL alarm signal present on a rear panel test point changes from a logic high to a logic low level. Upon access of this auxiliary function, the left hand display will read "BER XE-Y," with "XE-Y" representing (in scientific notation) the current BER threshold value. A new value may be entered by keying in a two digit number in which the first digit represents the one significant figure of the desired value and the second digit represents the negative exponent. Depression of the ENTER key terminates the entry procedure.

4.6.5.3 Block Length Select

(Access Code 64): This auxiliary function allows the user to choose the block length used by the DATA SENTRY receiver in performing data analysis. The user may select a block length equal to the length of the pattern or message to which the DATA switch is set, or to any fixed length between 63 and 65,535.

This auxiliary function is not applicable for either Half Duplex mode. In Half Duplex operation, the block length is equal to 1000 bits for pseudorandom patterns or, when Auxiliary Function 24 is ON it is equal to the pattern length. The block length is always equal to the message length for messages, or one character for preamble only.

Upon access of this auxiliary function, the abbreviation "BL" is displayed left hand justified, and either "P/M" (indicating

pattern or message length) or the current fixed block length is displayed right hand justified. Depressing the SCROLL key causes the block length parameter to toggle between "P/M" and the most recently set fixed block length. A new fixed block length may be entered at any time by keying in the desired value and then depressing ENTER. All entered digits will flash until the entry procedure is terminated by depression of the ENTER key.

Whenever the block length is set to a fixed value, the "AUX FUNC IN USE" LED will be illuminated to warn the user that the current block length is not the length of the pattern or message selected by the DATA switch. This auxiliary function is included in the automatic display of "in use" auxiliary functions (Auxiliary Function 00) and is affected by Auxiliary Function 99 which clears all "in use" auxiliary functions (See Section 4.6.2).

4.6.5.4 Trend 1-9-1 Message Download

(Access Code 65): This auxiliary function allows the user to automatically download four predetermined messages into user messages 1, 2, 3, and 4. Appendix C in this manual describes these four messages.

Upon access of this auxiliary function, the display will show "191 MSG?". Depressing the ENTER key causes the download of the four messages into the user messages. Note that messages previously stored as USER 1, USER 2, are written over and cannot be recalled. At this point this function is terminated and "AUX" is returned to the display.

4.6.5.5 SYN Character and Line Idle Selection

(Access Code 70): This auxiliary function allows the user to choose the SYN characters to be used with messages in the Synchronous and Recovered Timing modes. The SYN characters, the number of SYN characters, and the line idling condition are independently selectable for each of the four code levels. The information entered through this auxiliary function is maintained with the power off.

Upon access of this auxiliary function, the abbreviation "CD LVL?" is displayed. The desired code level (5, 6, 7, or 8) should be entered and the ENTER key depressed. Four complete sets of information are stored, one for each of the code levels.

The display will show "SYN" and the current SYN character values. If new SYN characters are desired, the new values should be entered (the display will flash to highlight the newly entered characters) and the ENTER key should be depressed. If the current SYN characters are acceptable, the ENTER key should be depressed.

Each SYN character group consists of two characters; these may be two identical characters or two distinct characters. The desired characters are entered as hex representations, two hex values per character. Four hex values must be entered at this point. Hex values larger than the code level allows (e.g. "FF" in 7-level code) are not accepted by the DATA SENTRY 10.

After the desired SYN characters have been entered, the display will show "# SYN" and the current value ("# SYN" may equal 1 or 2). This number represents the number of SYN character group repetitions transmitted. Each time SYN characters are used at the beginning of a message, either one or two repetitions of the SYN character group will be sent for a total of two or four characters at the selected code level. After a new number of SYN character groups is entered (the display will flash to highlight new entries), or if the current value is acceptable, the ENTER key should be depressed.

The display will then show "IDLE" and the current line idling value: either "SYN", "MK", or "SP". If "SYN" is selected, the line will idle with SYN character groups after data transmission is complete in the single Transmit mode or when waiting to transmit due to signaling conditions in the Single Transmit and Full Duplex modes. If "MK" is selected, the line will idle in the Mark state, and if "SP" is selected, the data line will idle in the Space state. The SCROLL key is used to move through the three selections. The currently selected value will not flash, while the other values are shown flashing. The desired line idling value is selected by depressing the ENTER key.

4.6.5.6 RS-449/MIL-188-114/MIL-188C Interface Control

(Access Code 85): Identical in operation to the Status Select functions described in Section 4.6.2, this auxiliary function is listed as a Special Function primarily because it has no "normal" setting. Consequently it does not affect the AUX FUNC IN USE indicator and is not affected by Auxiliary Function 99. The abbreviation appearing in the left side of

Table 4-5. Auxiliary Function 85 Status Choices

<u>Status Choice</u>	<u>Description</u>
188C	Selects MIL-188C mode of operation.
423	Interface electrical characteristics meet EIA specification RS-423-A.
422U	Interface electrical characteristics meet EIA specification RS-422-A with high impedance input to Category I line receivers.
422T	Same as 422U but all incoming Category I lines terminated in 130 ohm loads.

the display when Auxiliary Function 85 is accessed is "449", and the four available status choices are shown in Table 4-5.

Note that the setting of this auxiliary function may also be changed by an electronic switch on the Data Interface itself at any time when the auxiliary function is not accessed. Further information on the operating modes of the RS-449/MIL-188-114/MIL-188C Data Interface is provided in Section 8.4.

4.6.5.7 Clear The Printer Buffer

(Access Code 98): This auxiliary function has been provided to allow the user to clear the printer buffer at any time. Upon keying in the access code "98" followed by ENTER, the printer buffer is cleared and "AUX" is returned to the display. Note that leaving the PRINT EVENT switch in the "OFF" position also clears the printer buffer.

4.6.6 VF Measurement Module Selection

(Access Code 80): This auxiliary function allows the user to configure and control the optional Voice Frequency Measurement Module. The transmitter's output level and frequency, and the receiver's weighting filters and mode of operation can be controlled via this auxiliary function. Complete information on this auxiliary function may be found in Section 10.

4.6.7 Successive Access of Auxiliary Functions

Provision is made to allow the user to access two or more auxiliary functions successively without changing the setting of the DISPLAY/ENTRY switch. This necessitates being able to "exit" a given auxiliary function so that the test set does not interpret the access code of the next auxiliary function as a data input associated with the presently accessed function.

Such an auxiliary function exit may be performed by depressing the ENTER key at any time when an entry procedure is not in progress. Exiting any auxiliary function causes "AUX" to be returned to the display as an indication that the test set is ready to accept the access code of another auxiliary function.



)



SECTION 5

OPERATING INSTRUCTIONS AND APPLICATIONS INFORMATION

5.1 INTRODUCTION

This section contains detailed instructions for exercising each of the test capabilities provided by the DATA SENTRY 10. Step-by-step operating instructions are followed by a discussion of special considerations that should be given to the selection of operating mode, data type, and various other test parameters.

5.2 INSTRUMENT SETUP AND USE

5.2.1 User Interface with the DATA SENTRY 10

The DATA SENTRY 10 employs three main methods of test parameter and result selection. The first method uses electronic slide switches. Each switch consists of a column of rectangular LEDs and a push-button switch. Normally, one LED in the column will be illuminated to indicate the current parameter selection. When the push-button switch at the bottom of the column is depressed and released, the currently illuminated LED will turn off and the LED immediately above it will turn on. When the switch is depressed and held down, this sequencing action will continue automatically until the switch is released.

The second method of test parameter and result selection utilizes the 20-key hexadecimal keyboard, DISPLAY/ENTRY switch, and lefthand alphanumeric display. The keyboard allows simple and straightforward entry of numeric infor-

mation and hexadecimal code characters, as well as the selection of some non-numeric parameters. The DISPLAY/ENTRY switch is used to select one of six possible parameters to enter and display.

The third method of entering parameters also makes use of the keyboard, DISPLAY/ENTRY switch, and left-hand display. This method is used to enter auxiliary functions which do not have specific positions on the DISPLAY/ENTRY switch. These auxiliary functions are entered by selecting the "AUX" position of the DISPLAY/ENTRY switch and then keying in the two digit access code corresponding to the desired function. Detailed information on the available auxiliary functions and selection procedure is provided in Section 4.6.

5.2.2 Switch Contentions

Certain combinations of front panel switch settings are not allowed by the DATA SENTRY 10 either because they are contradictory or meaningless. These "switch contentions" fall into two categories, each of which is treated differently by the test set. The first type of contention involves combinations of switch settings which are contradictory or which violate specific operating restrictions set forth in this manual. An example of such a combination is the selection of the "INTF" position of the GEN CLK switch when the test set is emulating a DCE in the Recovered Timing mode. Because there is no interface clock available under these conditions, the generator clock must be obtained

from another source for the test set to operate properly. When a switch position conflict of this type occurs, the DATA SENTRY 10 alerts the user by causing the contending switch position LEDs to flash simultaneously. The flashing will continue and the test set will be inoperative until the user resolves the conflict by changing one of the switch settings. In the same manner, the Data Sentry 10 will alert the user in the event that the entered synthesizer or receiver frequency is out of the allowed range for the current operating mode and data type. In this case, the "SYNTH FREQ" and/or "RCVR FREQ" indicator LEDs on the DISPLAY/ENTRY switch will flash along with the LEDs indicating the positions of the switches that place a restriction on the operating frequency. This type of contention may be resolved by either placing the DISPLAY/ENTRY switch in the position corresponding to the flashing LED(s) and entering a valid operating frequency (see Section 5.3.4) or by changing the position of any of the other switches in which an indicator LED is flashing.

Whenever a switch contention occurs, the DATA SENTRY 10 does not allow the user to change the positions of any of the front panel switches not involved in the contention, with one notable exception: the user always has the option to resolve the switch contention by recalling a previously stored set of front panel switch settings and keyboard enterable parameters. This may be done by setting the DISPLAY/ENTRY switch to the "PROG" position and keying in the desired program number, followed by "ENTER". For more information on use of the front panel PROGRAM mode, see Section 4.5.1.

The second type of switch contention involves those cases in which an entire front panel switch is not applicable to the

selected mode of operation. For example, the STOP BITS switch is not applicable to the Synchronous or Recovered timing modes, making the setting of this switch meaningless in these modes. The DATA SENTRY 10 handles this situation by extinguishing all of the LED position indicators of the inapplicable switch, thus informing the operator that the setting of this switch does not affect the present mode of operation. The switches subject to being turned completely off in this manner are the CODE LEVEL, PARITY, STOP BITS, and BER INTVL switches. The on/off status of these four switches is determined by the settings of the DATA, TIMING, MODE, and RCVR FUNCTION switches.

5.2.3 Functional Division of the Instrument

Generally speaking, the DATA SENTRY 10 is divided into four functional blocks. These consist of the data generator, receiver, signal monitor, and signaling transceivers. A basic understanding of this division and the purpose of each of these blocks will be a great asset to the user in instrument setup and operation.

5.2.3.1 Data Generator

The data generator is that part of the instrument responsible for producing the various data patterns and messages that are transmitted from the DATA SENTRY 10 to the system under test. Using the front panel GEN CLK switch, the user may instruct the data generator to take its clock from the plug-in Data Interface, the rear panel EXT CLK IN BNC connector, or an internal frequency synthesizer (considered part of the data generator for this discussion). The selected generator clock along with the

output of the data generator are sent to the clock and data line drivers, respectively, of the Data Interface. When the test set is emulating a DTE, these drivers drive the transmit clock and transmit data lines of the interface, while in the DCE Emulate mode it is the receive clock and receive data lines that are driven.

5.2.3.2 Receiver

The DATA SENTRY 10's receiver is capable of functioning in one of two basic operating modes, depending upon the setting of the front panel RCVR FUNCTION switch.

When this switch is in the "ANALYZE" position it is the receiver's job to synchronize to the incoming data and provide the various error counts selectable by the DISPLAY I switch (bit error rate, errors, block errors, clock slips, etc.). When the RCVR FUNCTION switch is set to the "TRAP" position, the receiver scans the incoming data for a user-selectable character sequence and "traps" in memory the 128 characters both preceeding and following the detected trap sequence. Alternatively, the receiver may be instructed to trap in memory the first 255 characters received after depression of the START/RESTART button. In either case, the user may examine the trapped data by use of the keyboard and left-hand alphanumeric display. No error analysis is performed when the receiver is in Data Trap mode.

Data is provided to the input of the test set's receiver by a line receiver in the Data Interface. In the Synchronous timing mode, the receiver's clock signal is also supplied by the Data Interface. When the DATA SENTRY 10 is emulating a

DTE, these signals are taken from the receive data and receive clock lines of the interface, while in the DCE Emulate mode it is the transmit data and transmit clock interface signals that are supplied to the receiver.

The DATA SENTRY 10's receiver has the capability of working with asynchronous (start-stop) data as well as bit-oriented data streams not accompanied by a clock. With both of these types of data, clock recovery is performed internally and the user is required to enter the expected received data rate to an accuracy of ± 1 percent.

5.2.3.3 Signal Monitor

The third functional block of the DATA SENTRY 10 is the signal monitor, which consists primarily of circuits responsible for performing frequency, delay, and signal distortion measurements. The signal monitor's results are selectable by the DISPLAY II switch. Since the signal monitor operates independently of the receiver and data generator, most of its results are available whether or not the receiver is synchronized to the incoming data.

The four front panel indicator LEDs sharing the common label "RCVR INPUTS" are also controlled by the signal monitor. Illumination of the CLK ACT (clock activity) indicator signifies the presence of transitions on the receiver's clock input at a rate greater than about 7 Hz. Unless this LED is on, the receiver will be inoperative (except in the normal 16x Asynchronous mode). The MK (Mark) and SP (Space) LEDs are each illuminated for the duration of the respective state of the signal applied to the receiver's data input, thus giving an indication of the

presence of received data activity at the interface level. If the data supplied to the receiver by the Data Interface is the logical inversion of the data expected by the receiver, the DATA INV (data inverted) LED is illuminated to notify the user of this condition. The receiver's autopolarity circuit allows it to synchronize and operate properly regardless of data polarity.

5.2.3.4 Signaling Transceivers

The DATA SENTRY 10's signaling transceivers are responsible for providing signals to the Data Interface that control the states of those interface signaling leads that are driven by the test set, and for receiving from the Data Interface signals corresponding to the states of those signaling leads that are monitored by the test set. The states of all monitored signaling leads are continuously displayed by the four LED indicators in the upper right hand corner of the instrument's front panel. Each indicator bears the EIA RS-232-C designation of two signaling leads, one label appearing above the indicator and the other below it. When the instrument is emulating Data Terminal Equipment, the triangular "DTE" indicator immediately above the EMULATE switch is illuminated, and the upper labels on the signaling LEDs and switches apply. When the instrument is emulating Data Communications Equipment, the triangular "DCE" indicator immediately below the EMULATE Switch is illuminated, and the lower labels on the signaling LEDs and switches apply. When Data Interfaces other than the RS-232-C/V.24 interface are installed, the nearest equivalent signaling leads are supported. Section 8 specifies the exact leads supported for each available Data Interface.

Front panel switches on the DATA SENTRY 10 allow the user to control the states of three interface signaling leads. These switches are located just to the right of the EMULATE switch. As with the signaling monitor LEDs, these switches bear separate labels for DTE and DCE emulation. Each switch contains an internal indicator LED, the "on" condition of the LED corresponding to the ON state of the signaling line. The signaling switches operate in a push-on push-off manner in all operating modes except the Half Duplex modes, in which the test set automatically takes over control of the signaling leads to facilitate automatic line turnaround.

5.2.4 Selection of Data Interface and Emulation Mode

The first step in setting up the DATA SENTRY 10 for system testing is selecting and installing the proper Data Interface. In most cases, selection of a Data Interface involves nothing more than determining the interface standard used by the system to be tested and choosing a Data Interface that conforms to that particular standard. Data Interfaces are available for the DATA SENTRY 10 that meet various standards: EIA RS-232-C/CCITT V.24, CCITT V.35/Bell 306, or RS-449/MIL-188-114/MIL-188C. Consult TTC for a list of the currently available Data Interfaces.

Most of the Data Interfaces place some restriction upon operating frequency that limits the range of data rates over which the module is useful. Care must be taken not to operate the Data Interface outside the speed range set forth in its specifications if proper operation is to be ensured.

CAUTION

Data Interfaces should never be installed in or removed from the DATA SENTRY 10 while the power is on. Failure to heed this caution may result in damage to the Data Interface which will not be covered by warranty.

After selection of an appropriate Data Interface, the plug-in module should be inserted in the slot in the Data Sentry 10's rear panel labeled "DATA INTERFACE" with the power to the instrument turned OFF. The interface should be pressed in gently until the aluminum panel of the module makes contact with the rear panel of the DATA SENTRY 10. In order to prevent any possibility of the Data Interface being pulled out of the test set during operation by tension on the interface cable, etc., the two captive fasteners on the module's panel should be tightened securely by hand.

Next, the Data Interface must be connected to the system under test. Most Data Interfaces come equipped with two interface connectors that conform to the particular standard met by the module. The emulation mode in which the DATA SENTRY 10 is operated determines which of these connectors should be used to interface with the system under test. Figure 4-1 shows a typical DTE-to-DCE interface configuration, showing which device drives or expects to receive the various interchange signals.

In most cases, the DATA SENTRY 10 will need to be configured as Data Terminal Equipment (DTE) to test Data Communications Equipment (DCE). In these cases,

the interface cable from the system under test should be attached to the connector on the Data Interface marked "TO DCE," and the EMULATE switch on the front panel of the test set should be set to the "DTE" position.

Occasionally, the DATA SENTRY 10 will need to interface with part of a communication system that is configured as a DTE. This will usually happen when the equipment to be tested normally interfaces with communications equipment. For example, computer terminals and printers are generally configured as Data Terminal Equipment. To test such systems, the interface cable from the system should be attached to the connector on the Data Interface marked "TO DTE", and the EMULATE switch on the front panel of the test set should be set to the "DCE" position.

Under no circumstances should equipment be connected to both Data Interface connectors at the same time, as improper operation will result. It is also important to always maintain agreement between the setting of the EMULATE switch and the particular Data Interface connector to which the interface cable is attached.

5.2.5 Instrument Setup for Error Analysis

The following step-by-step sequence may be followed to prepare to make error analysis measurements with the DATA SENTRY 10. It is intended to serve as a guide and is not the only operating sequence.

1. Select a measurement configuration. If loopback testing is to be performed, only one DATA SENTRY 10 will be required. If end-to-end

testing is desired, two test sets will be needed and the setup procedure should be followed for the unit at each end of the link.

2. If an external printer or controller is to be used, connect it to the appropriate Printer/Controller Interface on the rear panel of the DATA SENTRY 10. Section 7 contains detailed information on the built-in RS-232 Printer/Controller Interface and the optional IEEE-488 and HP-IL plug-in interfaces.
3. Select the appropriate Data Interface and install it in the DATA SENTRY 10 with the power OFF. Section 5.2.4 provides information on Data Interface selection and use.
4. Connect the DATA SENTRY 10 to an ac power source and place the front panel power switch in the "ON" position. Allow the instrument time to complete its self-test before proceeding.
5. Determine whether the DATA SENTRY 10 needs to act as a DTE or a DCE to perform the desired test and set the EMULATE switch to the corresponding position.
6. Connect the interface cable from the system under test to the appropriate connector on the Data Interface as explained in Section 5.2.4.

NOTE

If during the following procedure a front panel switch is set to a position that

causes a switch contention signified by flashing position indicator LEDs, the user must resolve the contention before continuing. Section 5.2.2 contains more information on switch contentions.

7. Set the RCVR FUNCTION switch to the "ANALYZE" position.
8. Set the DATA and TIMING switches to the desired positions. For end-to-end testing both test sets must have their DATA switches in the same position. Sections 5.3.1 and 5.3.3 provide information on data and timing selection. Section 4.5.1 provides a description of each front panel switch.
9. Select the preamble and SYN character groups as required. See Sections 4.5.1.10 and 4.6.5.5 for more information.
10. Set the ERROR INSERT switch to "OFF".
11. Set the MODE switch to the "SELF LOOP" position regardless of what mode is to be used in the actual test. It is always a good idea to verify proper instrument operation and setup by operating the DATA SENTRY 10 in the Self Loop mode before performing "on line" testing. Selection of this mode causes the outputs of the clock and data drivers in the Data Interface to be looped back to the inputs of the clock and data receivers, thus also verifying operation of the Data Interface.

12. Set the GEN CLK switch to the position corresponding to the clock source to be used by the data generator. A red LED inside the switch will be illuminated if no clock signal is present at the selected source. If the internal synthesizer is chosen as the source of generator clock, the DISPLAY/ENTRY switch should be set to the SYNTH FREQ position and the desired clock frequency entered in hertz. Note that unless split frequency operation is selected by Auxiliary Function 14, the SYNTH FREQ and RCVR FREQ positions of the DISPLAY/ENTRY switch act as a single position with both indicator LEDs being illuminated simultaneously.
 13. If testing is to be performed in the Recovered or normal Asynchronous timing mode, set the DISPLAY/ENTRY switch to the RCVR FREQ position and enter the expected frequency of the data to be received by the test set in hertz. The entered frequency must be within one percent of the actual data frequency to guarantee proper reception. Note that when the DATA SENTRY 10 is configured to operate with a common synthesizer and receiver frequency, only a single entry is required to set both parameters. Receiver frequency entry is not required in the Synchronous or auxiliary Asynchronous (1x clock) timing modes since in these modes the receiver clock is provided by an external source.
 14. For Asynchronous operation, set the CODE LEVEL, PARITY, and STOP BITS switches to the desired positions. For Synchronous or Recovered operation with any of the data selections labeled as "MESSAGES", set the CODE LEVEL and PARITY switches to the desired positions.
 15. If bit error rate measurements are to be made, set the BER INTVL switch to the position corresponding to the number of bits over which the results are to be computed. Information on BER interval selection is provided in section 5.3.5.
 16. If blocks and block errors are to be measured, determine the desired block length. In Full Duplex mode, Auxiliary Function 64 may be used to set the block length to any value between 63 and 65,535 bits. Refer to Section 4.6.5.3 for information on the use of this auxiliary function.
 17. If the optional printer is installed or an external printer is connected to the DATA SENTRY 10, set the PRINT EVENT switch to the desired position.
 18. Set any auxiliary functions that are to be used. For a complete description of available auxiliary functions and their entry procedures, refer to Section 4.6. If the AUX FUNC IN USE indicator is illuminated prior to the setting of any auxiliary functions, one or more auxiliary functions are still set from the last time the instrument was used. The user may enter auxiliary access code 00 to obtain a menu of "in use" auxiliary functions, or may enter access code 99 to clear all of the "in use" functions.
- The DATA SENTRY 10 should now be operating with its data generator looped back to its receiver. The following indications should be present:
- a. The red warning LED inside the GEN CLK switch should be off. If it is

on and the switch is set to the "INTF" position, check to see that the maximum recommended operating speed for the installed Data Interface is not being exceeded. Also, make sure that the system to be tested is in fact supplying a clock to the DATA SENTRY 10 through the interface cable. If the GEN CLK switch is set to the "BNC" position and no clock activity is present, check the levels of the signal being applied to the rear panel BNC connector. (See Section 2.2.1.2)

- b. The LEDs labeled RCVR INPUTS should be in the following states:

CLK ACT - on (except in 16x Asynchronous timing mode)

MK - on or flashing unless generated data is all Spaces

SP - on or flashing unless generated data is all Marks

DATA INV - off unless Generator Data Invert auxiliary function is on.

If any of these indicators are not in the listed state, check that the Data Interface is installed properly and that its maximum recommended speed is not being exceeded.

NOTE: For proper Self Loop operation, Auxiliary Functions 12 and 13 must be set to select primary channel operation for both transmission and reception. Also, Auxiliary Function 07 (Receive Data Invert) must be set to OFF unless Auxiliary Function 06 (Generator Data Invert) is also on.

- c. The IN SYNC LED should be on, and the SYNC LOST indicator should be off.
- d. The center display should read "0" when the DISPLAY I switch is set to the "ERRS" position, indicating that no errors have been detected in the received data.

Now verify that the error count shown in Display I increments by one each time the ERROR INSERT switch is momentarily depressed.

Once successful operation has been achieved in loopback, the DATA SENTRY 10 is ready to perform online testing.

5.2.6 Performing Error Analysis Testing

Error analysis may be performed in all operating modes except Single Transmit, which is an output-only mode. All error analysis results are available through the DATA SENTRY 10's center display and DISPLAY I switch. Each position indicator LED in the DISPLAY I Switch carries two labels: the label to the right of the indicator corresponds to Half Duplex operation and the label to the left corresponds to Full Duplex operation, as indicated by the triangular LEDs immediately above each column of labels.

The specific error analysis results that the DATA SENTRY 10 provides in each mode of operation is a function of the timing mode and data type selected for the test. When a particular result is not available for a given operating mode, the center display indicates "N/A" when the

DISPLAY I switch is set to that result. Table 5-1 shows available error analysis results for each combination of timing mode and data type in Full Duplex operation, and Table 5-2 shows available results for Half Duplex operation. The same results are available in Self Loop mode as in Full Duplex mode.

5.2.6.1 Full Duplex Error Analysis

In the Full Duplex mode, the DATA SENTRY 10 simultaneously transmits data and analyzes received data. The received data on which error analysis is performed may either be the data transmitted by that test set (loop-around test) or data sent by another instrument (end-to-end test). Error analysis is performed continuously on all incoming data beginning at the instant synchronization is acquired. Normally, when synchronization is lost (as evidenced by an extremely high measured error rate) all results counters are cleared and the test is automatically restarted upon re-acquisition of sync. Alternatively, Auxiliary Function 16 may be set to instruct the receiver to merely suspend results accumulations during the time that the receiver is out of sync, or, as a third option, in some operating modes the receiver may be configured to continue counting all of the available results even during a sync loss (See Section 5.3.10.3).

In all cases, the first sync loss after the test start will cause the SYNC LOST indicator to be illuminated. It will remain lit to warn the user that a sync loss has occurred until either it is reset by depression of the SYNC LOST switch or the test is manually restarted. A manual test restart will result if any of the following actions are taken by the user:

- * the START/RESTART button is depressed
- * a new synthesizer or receiver frequency is entered
- * the received block length (Auxiliary Function 64) is changed
- * the settings of any of the following front panel switches are changed:

DATA
MODE
TIMING
GEN CLK
CODE LEVEL
PARITY
STOP BITS
BER INTVL
RCVR FUNCTION
EMULATE

- * the settings of any of the following auxiliary functions are changed:

03	17	44
07	22	60
12	23	64
13	24	65
14	41	70
15	42	85
16	43	

- * the ac power to the instrument is turned off and then on again

After setting up the DATA SENTRY 10 and achieving successful operation in the Self Loop mode according to the instructions given in Section 5.2.5, Full Duplex testing may be started by performing the following:

1. Set the MODE switch to the "FDX" position.

TABLE 5-1
FULL DUPLEX ERROR ANALYSIS RESULTS

TIMING MODE	SYNCHRONOUS			RECOVERED			ASYNCHRONOUS		
	Pseudorandom	Fixed Pattern	Messages	Pseudorandom	Fixed Pattern	Messages	Pseudorandom	Fixed Pattern	Messages
RESULTS									
BER	yes	yes	yes	yes	yes	yes	yes	yes	yes
Errors	yes	yes	yes	yes	yes	yes	yes	yes	yes
Blocks	yes	yes	yes	yes	yes	yes	yes	yes	yes
Block Errors	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sec of Test	yes	yes	yes	yes	yes	yes	yes	yes	yes
Error Free Seconds	yes	yes	yes	yes	yes	yes	yes	yes	yes
Clock Slips	yes	no	no	yes	no	no	no	no	no
Preambles Missed	no	no	no	no	no	no	no	no	no
Character Errors	no	no	yes	no	no	yes	yes	yes	yes
Parity Errors*	no	no	yes	no	no	yes	yes	yes	yes
Framing Errors*	no	no	no	no	no	no	yes	yes	yes

*Parity and Framing Errors are available for printout only.

TABLE 5-2
HALF DUPLEX ERROR ANALYSIS RESULTS

TIMING MODE	SYNCHRONOUS			RECOVERED			ASYNCHRONOUS		
	Pseudorandom	Fixed Pattern ¹	Messages	Pseudorandom	Fixed Pattern ¹	Messages	Pseudorandom	Fixed Pattern ¹	Messages
RESULTS									
BER	no	no	no	no	no	no	no	no	no
Errors	yes	no	yes	yes	no	yes	yes	no	yes
Blocks	yes	yes	yes	yes	yes	yes	yes	yes	yes
Block Errors	yes	no	yes	yes	no	yes	yes	no	yes
Sec of Test	yes	yes	yes	yes	yes	yes	yes	yes	yes
Error Free Seconds	no	no	no	no	no	no	no	no	no
Clock Slips	no	no	no	no	no	no	no	no	no
Preambles Missed	yes	yes	yes	yes	yes	yes	yes	yes	yes
Character Errors	no	no	yes	no	no	yes	yes	no	yes
Parity Errors ²	no	no	yes	no	no	yes	yes	yes	yes
Framing Errors ²	no	no	no	no	no	no	yes	yes	yes

1. Mark and 1:1 patterns not available in Half Duplex mode.
2. Parity and Framing Errors are available for printout only.

2. For DTE emulation, turn the DTR and RTS signaling controls ON. For DCE emulation, turn the DSR and RLSD signaling controls ON. Section 5.3.14 explains the role of interface signaling leads in the operation of the DATA SENTRY 10.

3. For DTE emulation, verify the ON condition of the DSR and CTS signaling status LEDs. Normally, these signaling leads must be held ON by the DCE for data transfer to take place. If either or both of these lines is not in the ON condition, the user may cause the DATA SENTRY 10 to act as if they were on by use of the Signaling Override auxiliary function (Auxiliary Function 08) or by use of the CTS Control or DSR Control auxiliary functions as applicable (Auxiliary Functions 19 and 20, respectively). For DCE emulation, verify the ON condition of the DTR signaling status LED. Normally, this signaling lead must be held ON by the DTE for data transfer to take place. If this line is not in the ON condition, the user may cause the test set to act as if it was on by use of the Signaling Override auxiliary function or by use of the DTR Control auxiliary function (Auxiliary Function 21).

Once proper signaling status has been achieved, the DATA SENTRY 10 will continuously transmit data to the system under test as indicated by the On condition of the green LED inside the START/RESTART switch. The test set should also be receiving data from the system under test. If the received data is of the same type as that selected by the DATA switch on the test set and has a bit error rate of about 10^{-1} or less, the DATA SENTRY 10's IN SYNC indicator should be on and error analysis results should be available in the center display.

No BER measurement will be available until the instrument has been synchronized to the incoming data for a number of bits equal to the selected BER interval. For information on BER interval selection, refer to Section 5.3.5.

If the DATA SENTRY 10 is not synchronized to the incoming data, first make sure that the RCVR INPUTS LEDs indicate the presence of received data. For tests in the Synchronous, Recovered, or 1x Asynchronous timing modes the CLK ACT LED should also be on.

If an end-to-end test is being performed, verify that both test sets have their DATA switches set to the same position. Both instruments must also be set for the same code level, parity, and number of stop bits when these parameters are applicable. If message data is being used in the Synchronous or Recovered timing modes, both instruments must have their SYN characters (Auxiliary Function 70) set to the same value. If the test set's receiver does not detect the proper SYN characters in the incoming data, "NO SYN" will be shown in the center display. For Asynchronous and Recovered timing, verify that the DATA SENTRY 10's receiver frequency is set to the proper value.

The DATA SENTRY 10's autopolarity circuit allows the test set to synchronize to received data that is logically inverted with respect to the expected pattern or message. Applying inverted data to the test set's receiver extends the time required for synchronization by approximately 64 bit periods for pattern data in the Synchronous or Recovered timing modes. When asynchronous timing is employed or the DATA switch is set to one of the "message" positions, inverted receiver data extends the sync-up time by about 30 seconds unless Auxiliary Function 07 (Receiver Data Invert) is set to ON.

Once receiver synchronization has been achieved, error analysis results will be available in the center display. Errors may be inserted in the generated data stream singly or at a 10^{-5} error rate to verify the data path. For looparound testing, the inserted errors should be counted by the test set that inserted them. For end-to-end testing, errors inserted at one end should be counted at the other location.

After verifying proper operation of the DATA SENTRY 10 through the system under test, place the ERROR INSERT switch in the "OFF" position and depress the START/RESTART button to clear the results accumulators and start the test.

At any time during the test all of the results available in both the center and right-hand displays may be temporarily "frozen" by depressing the DISPLAY HOLD switch. This feature allows the user to compare all of the available results at the same instant in time without interrupting the actual test.

While the Display Hold is on, a red LED inside the switch warns the operator that the displayed results are not being updated. Depressing the switch a second time turns off the Display Hold feature and places the current results in the displays.

5.2.6.2 Half Duplex Error Analysis

In Half Duplex mode, the DATA SENTRY 10 automatically alternates between data transmission and data reception and analysis each time the line to the DCE is turned around. When the test set has control of the line it will transmit one complete message, one character of a

preamble, or 1000 bits (or one complete pattern) of a pseudorandom pattern, after which it automatically falls into the receive mode and relinquishes line control. In the receive mode, the test set expects to receive the same type of data it just transmitted (as determined by the DATA switch setting). The test set immediately synchronizes to the incoming data and begins to provide error analysis results.

All error analysis results are cumulative in the Half Duplex modes; the error counters are not reset after each line turnaround. At any time during a test, the error counters may be cleared and the test restarted by depressing the START/RESTART pushbutton.

Table 5-2 shows the error analysis results available for each timing mode and data type in Half Duplex operation. The results are defined as follows:

Errors - The number of bits received in error since the beginning of the test.

Blocks - The number of line turnarounds (RLSD On) since the beginning of the test.

Blocks Analyzed - The number of patterns or messages since the beginning of the test to which the receiver has properly synchronized and on which error analysis has been performed. Only one block may be analyzed per line turnaround, and the analyzed block length is equal to the message length for messages, one character for PREAM ONLY, and 1000 bits or the pattern length for pseudorandom patterns. Additional data received after a block has been analyzed is ignored, and missing data (when less than a block is received) is counted as 100% errors.

Block Errors - The number of analyzed blocks since the beginning of the test containing one or more bit errors.

Seconds - The time elapsed in seconds since the beginning of the test. The timer is started when START/RESTART is depressed or upon the first RLSD Off-to-On transition.

Preambles Missed - For Synchronous and Recovered messages, the number of blocks since the beginning of the test in which the SYN characters contain one or more bit errors. For all other modes of operation, the number of blocks since the beginning of the test in which the last character of the preamble contained one or more bit errors.

Character Errors - The number of characters in analyzed blocks received since the beginning of the test containing one or more bit errors.

In the Asynchronous Timing mode, messages may be preceded by a one- to four-character preamble. The last preamble character is checked to update the Preambles Missed count, but no error analysis is performed on the preamble. Message synchronization is achieved when the first group of 10 characters (or one half of the message length for shorter messages) are received which sequentially match 10 characters in the selected message. Once synchronization has been achieved, the alignment of the incoming message with respect to the selected message is known, and error analysis is started with the received character corresponding to the first character in the message. Analysis is performed sequentially through the received data and stops at the received character corresponding to the last character in the message. Extra characters received preceding or following the points where the message is assumed to have started or ended are ignored. If sufficient characters are

not received or if RLSD is turned Off prematurely, the missing characters are counted as 100% in error.

In the Synchronous and Recovered Timing modes, messages are always preceded by SYN characters. The message will not be analyzed and the Blocks Analyzed count will not be incremented if the SYN characters are not correctly received. A complete line turnaround (RLSD turned On, then Off again) without proper SYN character reception will cause the Preambles Missed count to be incremented. A one-to-four character preamble may precede the SYN characters, but the preamble is not analyzed in any manner. Message synchronization and analysis are identical to that for messages in the Asynchronous Timing mode.

In the Asynchronous Timing mode when the DATA switch is set to "PREAM ONLY", one character is transmitted and received per line turnaround, making this pattern equivalent to a one-character user message without a preamble. The receiver compares the first character received with the selected preamble and increments the Preambles Missed count if a match is not achieved. The "IN SYNC" LED will be illuminated whenever RLSD is On.

In the Synchronous and Recovered Timing modes when the DATA switch is set to "PREAM ONLY", one 8-bit character without any accompanying SYN characters is transmitted per line turnaround. As characters are received, they are scanned in a bit-by-bit fashion for the transmitted character. If the character is not received before RLSD is turned Off, the Preambles Missed count will be incremented. The "IN SYNC" LED will be illuminated whenever RLSD is On.

In the Asynchronous Timing mode, the received preamble characters are assumed to have correct character alignment, and the last preamble character is checked to update the Preambles Missed count.

The preamble is followed by the minimum number of characters which contain 1000 bits or a complete pattern, as determined by the setting of Auxiliary Function 24. Correct character alignment for the pseudorandom data is not assumed, and the received data is scanned on a bit-by-bit basis. Synchronization is achieved when 32 consecutive error-free bits are received, and the Blocks Analyzed count is incremented upon synchronization. Error analysis is performed until 1000 bits or a complete pattern has been received or RLSD has been turned off. If RLSD is turned off before the expected number of bits have been received, the missing bits are assumed to be 100% in error.

In the Synchronous and Recovered Timing modes, pseudorandom patterns may be preceded by a one-to-four character preamble, but no SYN characters are provided or required. The last character of the preamble is checked to update the Preambles Missed count, but no other error analysis is performed on the preamble. Correct character alignment of the preamble and the pseudorandom data is neither assumed nor required. Synchronization is achieved when 32 consecutive error-free bits are received, and the Blocks Analyzed count is incremented upon synchronization. Error analysis is performed until all expected bits have been received or RLSD has been turned off. If RLSD is turned off before all of the expected bits have been received, the missing bits are assumed to be 100% in error.

Several selectable time intervals are provided to aid in the diagnosis of half duplex system problems. See Section 4.4.3.3 for details on these delay intervals.

5.2.7 Single Transmit Mode

The Single Transmit mode of operation allows the DATA SENTRY 10 to transmit a single pattern or message and then stop transmitting until another single transmission is desired. The single Transmit mode of operation is selected by the "SNGL TX" position of the MODE switch, and each single transmission is initiated by pressing the START/RESTART switch. Note that no error analysis is performed in the Single Transmit mode.

After the START/RESTART switch has been pushed, the following data are transmitted:

- * Preamble - if selected, up to four preamble characters are sent.
- * SYN Characters - if messages are to be transmitted in the Synchronous or Recovered Timing modes, one or two SYN character groups are sent as selected through Auxiliary Function 70.
- * The selected pattern or message data is sent.

For messages and pseudorandom patterns, the number of data bits equals the pattern or message length. For the MK and 1:1 patterns, 1000 bits are sent; for PREAM ONLY one character is transmitted.

Just as in the FDX mode, transmission is conditioned on the status of the signaling leads. In the Emulate DTE mode, RTS and DTR must be set ON via their front panel switches, and CTS and DSR must be received in the ON state. In the Emulate DCE mode, DSR and RLSD must be set ON via their front panel switches, and DTR must be received in the ON state. Auxiliary Function 08 (Signaling Override) may be used to bypass all signaling restrictions, and Auxiliary Functions 19, 20, and 21 may be used to selectively override the received CTS, DSR, and DTR signaling inputs, respectively.

After the single data transmission, the data line goes to its idle condition. For messages in the Synchronous and Recovered Timing modes, the line idling state or characters are selected by Auxiliary Function 70. For all other operating modes, the data line goes to the Mark condition.

5.2.8 Frequency, Delay, and Distortion Measurements

The DISPLAY II switch allows the user to select one of seven test results or the time of day for viewing on the right-hand display. Bias and telegraph distortion, receiver and generator clock frequencies, and delay measurements are provided by the DATA SENTRY 10's internal signal monitor, while the audio level and frequency measurements are provided by the VF Measurement Module if it is installed. All seven measurements are made independently of the test set's receiver and are, therefore, available regardless of receiver sync status or the setting of the RCVR FUNCTION switch.

Although only one test result may be displayed at a time, all of the measurements are made simultaneously so no

measurement delay will be experienced by the user when switching from one result to another. Activating the Display Hold function causes all of the results selectable through the DISPLAY II switch to be temporarily frozen. Depressing the START/RESTART button causes the current results to be cleared and all the measurements to be restarted.

Information on display formats for the different results is given in Section 4.5.1.

5.2.8.1 Telegraph Distortion

The measured values of telegraph distortion are displayed in conjunction with the MAX and 2 SEC MAX indicators just to the right of DISPLAY II. The display normally shows the maximum value of telegraph distortion measured over the last two seconds as indicated by the illumination of the 2 SEC MAX LED. Every 12 seconds the TEST MAX indicator is illuminated for two seconds indicating that the displayed value during that time is the maximum value measured since the beginning of the test.

Auxiliary Function 23 allows the user to select whether telegraph distortion is measured as jitter or peak distortion for the Recovered timing mode. In the Asynchronous timing mode, gross start-stop distortion is measured and displayed. Definitions of the various distortion measurements are provided in Section 4.3.4.2. Additional considerations for making distortion measurements are given in Section 5.3.11.

5.2.8.2 Bias Distortion

Bias distortion is continuously measured on the data appearing at the input to the

receiver in all modes of operation over the full range of operating speeds of the DATA SENTRY 10. The displayed result indicates percentage distortion toward Mark or Space and reflects the ratio of total time spent in one binary state to total time spent in the other; hence, a true bias distortion measurement will only be obtained on data patterns containing equal numbers of Marks and Spaces. Section 4.3.4.1 provides a precise definition of bias distortion. For information on increasing the stability of the bias distortion measurement at low data rates, refer to section 5.3.11.

5.2.8.3 Receiver Frequency

The frequency of the clock accompanying the incoming data (for Synchronous and 1x clock Asynchronous timing) or the recovered clock (for the Recovered Timing mode) is continuously measured and displayed in hertz. The measurement interval is normally 1 second, but Auxiliary Function 18 may be used to select a 10 second or 100 second interval for greater resolution. Information on frequency measurement accuracy as a function of frequency, measurement interval, and time base accuracy is given in Section 5.3.12.

Special considerations apply to receiver frequency measurements made in Half Duplex operation. Receiver frequency measurements are made only while data is actually being received to assure that the displayed value corresponds to the actual received data rate.

Because the frequency measurement interval is restarted after each line turnaround, care must be taken to ensure that the frequency measurement interval (as selected by Auxiliary Function 18) is shorter than the receive portion of the Half Duplex cycle.

5.2.8.4 Generator Clock Frequency

The frequency of the clock selected by the DATA SENTRY 10's GEN CLK switch is continuously measured and displayed in hertz. Measurement interval choices and their corresponding resolutions are the same as those for receiver frequency. This measurement is available in all timing modes.

Special considerations apply to generator frequency measurements made in the Half Duplex modes. Generator frequency measurements are made during both the transmit and receive portions of the Half Duplex cycle. However, because the frequency measurement interval is restarted upon each line turnaround, care must be taken to ensure that the frequency measurement interval (as selected by Auxiliary Function 18) is shorter than half of the Half Duplex cycle.

5.2.8.5 Delay

The result of the delay measurement is displayed in milliseconds. Delays of up to 9.999 seconds may be measured. The result is held in the display until the START/RESTART button is depressed, after which the test set is prepared to make another delay measurement. The events between which the delay is measured may be selected through the keyboard and left hand display (See Section 4.5.1). The measurement may be started on the rising or falling edge of any one of eight start-of-measurement signals, and is terminated on the rising or falling edge of any one of eight end-of-measurement signals. These signals are:

Start-of-Measurement

Data Terminal Ready (DTR)
Data Set Ready (DSR)
Request to Send (RTS)
Clear to Send (CTS)
Carrier Detected (CD)*
Output Data
Data Generator Active
Input X

End-of-Measurement

Data Terminal Ready (DTR)
Data Set Ready (DSR)
Request to Send (RTS)
Clear to Send (CTS)
Carrier Detected (CD)*
Receiver Data
Detection of Trap Characters
Input Y

DTR, DSR, RTS, CTS, and RLSD represent the EIA RS-232 designations of five important interface signaling leads. When a Data Interface other than the RS-232-C/V.24 interface is used, delays may be measured between transitions of the corresponding signaling leads of the installed interface. The individual Data Interface descriptions provided in Section 8 give the correspondence between the RS-232 designations for each signaling lead and designations used by the other types of Data Interfaces. For all Data Interfaces, the ON condition of each signaling lead is represented by a logic high and the OFF condition by a logic low. "Data Generator Active" is a signal internal to the DATA SENTRY 10 that

assumes a logic high level whenever the data generator is outputting data to the Data Interface. Selecting the rising edge of this signal for the start-of-measurement parameter causes the delay to be measured from the instant the test set begins to send data to the system under test. Selecting the falling edge of this signal causes the delay to be measured from the instant the test set stops sending data to the system under test (end of transmission).

"Output Data" and "Receiver Data" are the digital signals appearing at the output of the data generator and input of the receiver, respectively. At these points in the test sets circuitry, a logic high always represents a Mark on the corresponding interface line and a logic low always represents a Space, regardless of which Data Interface is installed or the settings of the Generator Data Invert or Receiver Data Invert auxiliary functions.

"Input X" and "Input Y" refer to signals applied by the user to the rear panel test points designated "X" and "Y." These inputs add versatility to the DATA SENTRY 10's delay measurement capability by allowing the user to measure the time between transitions of any two digital signals. Electrical specifications for the X and Y inputs are given in Section 2.

When "Detection of Trap Characters" is selected as the end of measurement signal, no edge selection is necessary.

*Carrier Detected is synonymous with Receive Line Signal Detect (RLSD).

If the elapsed time between the occurrences of the selected start-of-measurement and end-of-measurement events is greater than 9999 milliseconds, a counter overflow condition will result and " 9999 MS" will be displayed. Unless an overflow condition occurs, the display will remain blank until the measurement is completed.

5.2.9 Saving the Instrument Configuration

The DATA SENTRY 10's non-volatile memory enables it to "remember" the settings of all front panel switches as well as all keyboard selectable parameters even when ac power is removed from the instrument. Upon restoration of power the last used switch settings and parameter values are automatically restored to the test set.

In addition to this feature, the DATA SENTRY 10 allows the user to store up to 10 complete sets of front panel switch settings and keyboard selectable parameters for guide recall at some future time. These 10 "programs" are also retained with the power off. Information on storing and recalling instrument configurations is given in Section 4.5.1.

5.3 OPERATING CONSIDERATIONS

5.3.1 Data Selection

The DATA SENTRY 10 offers two basic types of data to be used in system testing. These data types consist of "patterns" and "messages", as indicated on the DATA switch, and each type has its advantages as well as limitations.

"Pattern" data consists of predetermined bit sequences varying in length from 5 to 4095 bits. These sequences are transmitted singly or in blocks in the Half Duplex and Single Transmit modes and repetitively in the Full Duplex and Self Loop modes.

The positions of the DATA switch marked "63", "511", "2047", and "4095" provide pseudorandom patterns with lengths (in bits) equal to their numeric designation. Note that these lengths correspond to the value of the expression $2^N - 1$ for $N = 6, 9, 11$, and 12 respectively.

Each $2^N - 1$ length pattern has the property that it contains a maximum number of sequential ones (Marks) equal to N and a maximum number of sequential zeros (Spaces) equal to $N - 1$. Thus, the longer patterns contain longer segments of data in which no transitions occur. This is an important consideration for testing certain systems with clock recovery since long data segments with no transitions will stress clock recovery loops and may cause clock recovery problems. Problems of this nature generally result in the occurrence of clock slips, which can be counted by the DATA SENTRY 10 on pseudorandom data only. Pseudorandom patterns also have the property of a ones to zeros ratio of nearly unity, each

pattern containing exactly one more "one" (Mark) than it does zeros (Spaces). For example, the 511 pattern contains 255 zeros and 256 ones and has a maximum of 8 sequential zeros and 9 sequential ones.

The positions of the DATA switch labeled "MK", "1:1", and "PREAM ONLY" provide what are referred to as "fixed patterns". The "MK" position gives a data output of 1000 bits of Mark and the "1:1" position gives a data output of 1000 bits of alternating Mark and Space. In the Self Loop and Full Duplex modes data output does not stop after 1000 bits but continues indefinitely. Selecting the "PREAM ONLY" position of the DATA switch in the Synchronous or Recovered Timing mode causes a user-defined 8-bit pattern to be transmitted by the data generator and expected by the receiver. The pattern used is that bit sequence defined by the last character of the user-selected preamble (refer to Section 4.5.1 for preamble entry procedure). The bits comprising this character are always sent in order of increasing significance. For example, if the last character of the preamble is represented by the hexadecimal digits E1, the Preamble Only output will be 10000111 in transmission order. When Asynchronous timing is chosen, the setting of the CODE LEVEL switch determines the number of bits of the last preamble character that are transmitted. Thus, if the CODE LEVEL switch is set to "6", the test set will send an asynchronous character (framed with start and stop bits) whose 6 information bits correspond to the 6 least significant bits of the last preamble character. If desired, the PARITY switch may be set so that a parity bit is added to the asynchronous character thus generated. In this manner, any 5, 6, 7, or 8 level code character may be sent singly or repetitively in the Asynchronous timing mode.

It is important to note that whenever Asynchronous timing is chosen all data outputs are automatically framed with start and stop bits, and a parity bit may be added to each character depending upon the setting of the PARITY Switch. The setting of the DATA switch merely determines what is contained in the information bits of each character.

The five positions of the DATA switch designated "MESSAGES" provide data outputs that are character formatted regardless of timing mode. All messages may be sent in 5, 6, 7, or 8 level code with a choice of odd, even, or no parity. Start and stop bits are automatically added to each character in the Asynchronous timing mode. The positions of the DATA switch labeled "USER 1" through "USER 4" select user defined messages of up to 200 characters each that may be entered through Auxiliary Functions 41 through 44.

When a user defined message is entered into the test set's memory, only the information bits of each character are stored. This leaves the user free to select the code level and parity (as well as the number of stop bits in Asynchronous timing mode) each time a user defined message is chosen for transmission. When the code level switch is set to 5, 6, or 7, the 5, 6, or 7 least significant bits of each hex character pair are transmitted. The hex character pair is transmitted in its entirety when an 8 level code is selected. The information bits within each code character are always transmitted in order of increasing significance.

The DATA SENTRY 10 provides a FOX test message for transmission in all timing mode in 5, 6, 7, or 8 level code. The message takes the form:

THE QUICK BROWN FOX JUMPS
OVER THE LAZY DOG
1234567890(CR)(LF)

The specific code used by the test set is determined by the code level chosen as follows:

- 5 level - Baudot
- 6 level - BCDIC
- 7 level - ASCII
- 8 level - EBCDIC

An optional parity bit is user selectable in all timing modes and the number of stop bits added to each character is selectable in the Asynchronous timing mode.

The four user defined messages and the FOX message are restricted to a maximum data rate of 20 kbps.

5.3.2 Reverse Pseudorandom Pattern Capability

Most digital test sets employing pseudorandom test patterns of the same lengths as those provided by the DATA SENTRY 10 will be functionally compatible with it when both instruments are set to the same pattern length. This makes it possible to perform end-to-end testing using a DATA SENTRY 10 on one side of the link and another test set on the other side. There are, however, a few test sets that use the same length pseudorandom patterns as the DATA SENTRY 10 but transmit them in the reverse order,

making it impossible for the DATA SENTRY 10 to synchronize to their data output and for the other test set to synchronize to the DATA SENTRY 10's output. To accommodate such a situation, the DATA SENTRY 10 contains jumper wires that may be moved to allow it to transmit and/or receive any or all of the four pseudorandom patterns in the reverse order.*

Contact TTC for modification instructions for reverse pseudorandom patterns.

5.3.3 Timing Selection

When the DATA SENTRY 10 is expected to transmit and receive character formatted data framed with start and stop bits the TIMING switch must always be set to the "ASYNC" position. No clock signals are exchanged with the data in the Asynchronous timing mode unless Auxiliary Function 15 is used to select 1x Asynchronous operation. In normal Asynchronous operation, the user is required to enter the expected frequency of the incoming data.

If the DATA SENTRY 10 is to receive data with no start and stop bits and no accompanying clock signal, the Recovered timing mode must be selected and the received data rate entered to an accuracy of ± 1 percent. In this timing mode, the test set uses transitions in the received data to reconstruct a clock signal which is then applied to the receiver's clock input.

*This reverse pattern capability is not available in Half Duplex operation or when Asynchronous Timing is being used.

Normally, the Synchronous timing mode should be selected when data is to be exchanged without start and stop bits but with accompanying clock signals. In this mode the DATA SENTRY 10 expects to find a clock accompanying the received data on the Receive Clock interface lead when DTE emulation is selected. When the test set is emulating a DCE it first checks for the presence of a clock signal on the Transmit Clock (DTE Source) line. If no source of timing is detected on this line the test set automatically takes its receiver clock from the Transmit Clock (DCE Source) Line (driven by the test set itself). This automatic clock selection may be overridden through Auxiliary Function 22.

If the DATA SENTRY 10 is configured to test a synchronous communication system but seems to have trouble remaining synchronized to the incoming data, set the DATA switch to one of the pseudorandom patterns and check to see if clock slips are being counted. Clock slips are generally indicative of either a noisy clock signal or a clock that is not frequency locked to the data. This latter condition could arise if the test set is emulating a DCE and the DTE to which it is connected is generating its own source of transmit timing but not sending it to the test set. In this case the test set would default to using its own generator clock signal (Transmit Clock (DCE Source)) to clock data into its receiver, and if there was even a slight difference between the frequency of the DTE's clock source and the DATA SENTRY 10's generator clock, clock slips would result. The clock could be isolated as the source of trouble by selecting the Recovered Timing mode, which would cause the DATA SENTRY 10 to derive its receiver clock from the transitions in the received data alone. This would give the receiver a clean frequency and phase-locked clock with which to work, and clock slips

should no longer be counted. If sync losses still occur after switching to the Recovered Timing mode, it can be reasonably assumed that they are due to bursts of errors in the received data exceeding the receiver's sync loss threshold. For information on operating the DATA SENTRY 10 in a high BER environment, refer to Section 5.3.8.1.

5.3.4 Operating Speed Limitations

A few of the capabilities provided by the DATA SENTRY 10 do not function over the full 10 bps to 500 kbps operating speed range of the instrument. These operating speed restrictions are as follows:

Limited to below 10 kbps:

1. Half Duplex operation in the Recovered Timing mode.
2. All telegraph distortion measurements.

Limited to below 20 kbps:

1. Half Duplex operation in the Synchronous Timing mode.
2. All Asynchronous operation.
3. The use of "message" data.
4. Data Trapping.

In addition to these limitations, many of the plug-in Data Interfaces place further restrictions on operating speed which should be heeded by the user to ensure proper operation of the instrument.

5.3.5 BER Interval Selection

The BER interval should be chosen such that enough errors are accumulated during each measurement interval to produce a statistically reliable result. If the errors in the received data are statistically independent, a test interval that collects more than 100 errors will provide a result within 20% of the true average error rate with a 94% confidence level. In some cases, errors may not be statistically independent. Differential encoders, selfsynchronizing scramblers or other devices in the communication system, or channel characteristics may cause errors to occur in groups. If this is the case, the BER interval should be chosen to accumulate a larger number of errors to ensure reliable results.

Since the display of measured bit error rate provided by the DATA SENTRY 10 only shows significant digits, the exact number of errors detected in each measurement interval can be deduced from the display format as shown in Table 5-3. For example, if the display reads "5.9 E-4," exactly 59 bit errors were detected during the most recent measurement interval.

It should be noted that at low data rates and/or under low BER conditions it may take a long time to make a statistically reliable bit error rate measurement. In order to accumulate at least 100 errors in the measurement interval, the BER INTVL switch should be set to at least two orders of magnitude above the reciprocal of the anticipated bit error rate. Thus if the expected BER is 10^{-5} , the BER interval should be set to 10^7 bits. At a data rate of 9600 bps, for example, the time duration of this interval would be 17.4 minutes.

5.3.6 Block Length Selection

In Full Duplex mode, the received block length used by the DATA SENTRY 10 for block and block error measurements is normally equal to the length of the pattern or message (1000 bits for MK and 1:1 patterns) to which the DATA switch is set. If desired, Auxiliary Function 64 may be used to change the block length to any fixed value between 63 and 65,535 regardless of DATA switch setting. Activation of this auxiliary function causes illumination of the AUX FUNC IN USE indicator.

Table 5-3. BER Display Format

<u>Number of Bit Errors In Interval</u>	<u>Display Format</u>
0 - 9	X. E-X
10 - 99	X.X E-X
more than 99	X.XX E-X

Block and block error measurements made in conjunction with BER measurements are useful in determining information about the statistical distribution of errors. For example, if a BER of 1×10^{-4} is measured over a 10^6 bit test interval and in this same interval 100×10^4 -bit blocks are received with only two block errors, it can be inferred that the errors are occurring in bursts. If the test were repeated with $10,000 \times 10^2$ -bit blocks and only several block errors were counted, it can further be inferred that the errors are occurring in relatively short bursts (less than 100 bits).

5.3.7 Use of BER and Receiver Frequency Alarms

The DATA SENTRY 10 provides two TTL level alarm signals to rear panel test points. The test point labeled "BER ALARM" is driven low whenever the bit error rate measured during the most recently completed BER interval exceeds the value set by the user through Auxiliary Function 62. The RCVR FREQ ALARM test point is driven low whenever the measured receiver clock frequency falls outside the "window" set through Auxiliary Functions 36 and 37. Both of these test points are driven by open-collector gates having a maximum collector-emitter voltage rating of 30V and maximum continuous collector current rating of 300 mA. This high sink current capability allows these two outputs to be used to operate relays or other high current devices that require a dc supply of 30V or less.

In order to increase the versatility of the two alarm outputs, each output is internally connected to a +5V supply through a 27k resistor. This allows these outputs to directly drive up to 2 TTL loads or up to 4 LS TTL loads.

Because of their high resistance, the internal pull-up resistors will not affect the use of the open-collector outputs to drive high current loads.

5.3.8 Receiver Configurations

Through the use of auxiliary functions and plug jumpers the DATA SENTRY 10's receiver can be tailored to a variety of operating environments and user requirements. This section describes the available receiver configurations and explains how to obtain them and when they should be used.

5.3.8.1 Operating in a High BER Environment

For all data that is not character formatted (i.e., pattern data in the Synchronous and Recovered timing modes), the DATA SENTRY 10's receiver will declare a sync loss and attempt to resynchronize to the incoming data when it has detected 32 errors in 128 or fewer bits of data. This threshold allows sync losses to be declared quickly and, under most operating conditions, accurately. Gaussian error rates of up to 10^{-1} may easily be measured in this configuration.

When performing BER testing on a channel exhibiting a very high average error rate or occasional large bursts of errors, it is important for the test set to be able to remain synchronized to the incoming data at all times so as to obtain accurate test results. If the DATA SENTRY 10 has trouble remaining synchronized to the data in the normal configuration, the sync loss threshold can be changed to 240 errors in 1024 or fewer bits of received data by moving plug jumpers JW9 and JW22 on the receiver board from the "A" positions to the

"B" positions. This will allow the receiver to remain synchronized to the incoming data even in the presence of burst error rates of 0.5 lasting for several hundred bits. Note that this change affects the threshold only for Full Duplex patterns.

The ability of the receiver to remain synchronized in a high BER environment may be further increased (for either setting of the sync loss threshold) by disabling the autosync circuit through the use of Auxiliary Function 03. When the autosync circuit is disabled, the IN SYNC and SYNC LOST indicators will still respond to the occurrence of high error rate conditions in accordance with the selected sync loss threshold, but error analysis will continue regardless of sync status once initial synchronization has been achieved.

To prevent the accumulation of unusable results should a true loss of synchronization occur (as opposed to a temporary high BER condition), resynchronization is attempted whenever the bit error rate over a complete BER interval is greater than or equal to 0.4 (4.00 E-1).

5.3.8.2 Counting Clock Slips

Clock slips are counted only in the Full Duplex Synchronous and Full Duplex Recovered modes with pseudorandom pattern data. Each time a clock slip occurs the clock slip count is incremented by 1 and the clock and data are internally re-phased to allow error analysis on the incoming data to continue. Because re-phasing the clock and data involves what amounts to a receiver resynchronization, clock slip detection and correction is not performed when the receiver's autosync circuit has been

disabled by Auxiliary Function 03, except after a complete BER interval where the BER was greater than or equal to 0.4 (4.00 E-1).

Since it is impossible to count errors accurately around a clock slip, all error analysis circuitry is disabled approximately 20 bit periods before the data affected by a clock slip reaches this circuitry. No error analysis is performed on the next 50 bits of incoming data by the end of which the clock and data have been rephased by the test set and the error analysis circuitry may resume normal operation. Thus a 50 bit segment of the test is discarded each time a clock slip occurs. Unless successive clock slips occur less than about 30 clock cycles apart, they will not affect the error count.

As a consequence of the method of clock slip detection used, all incoming data is delayed by 50 bit periods before being applied to the error analysis circuitry.

The effect of this delay will be manifested most clearly at low data rates (about 200 bps or lower) when a loop-around test is being performed. Under these circumstances there will be a noticeable delay between the time an error is forced in the transmitted data (by momentarily depressing the ERROR INSERT switch) and the time the bit error count is incremented. The maximum possible length of this delay is 5 seconds and will occur at a data rate of 10 bps. The 50 bit data delay is only present in Synchronous and Recovered Full Duplex operation when the DATA switch is set to any of the positions labeled as "PATTERNS".

5.3.8.3 Sync Losses

A loss of receiver synchronization to the incoming data is characterized by a large and sudden increase in the measured bit or character error rate. The error rate conditions that are interpreted by the test set as a loss of sync are specified in Section 2.3.2. Some of the possible causes of a sync loss are:

- * Loss of received clock (Synchronous or 1x Asynchronous timing).
- * Data dropout (Synchronous or Recovered timing).
- * Sudden change to "garbage data" (any timing mode).
- * Multiple Framing errors (Asynchronous Timing).
- * Clock slip (Synchronous or Recovered Timing).

Clock slips will cause a loss of sync condition under all circumstances except when the test set is configured to operate with pseudorandom patterns in the Full Duplex Synchronous or Full Duplex Recovered mode. As explained in Section 5.3.8.2, clock slips are detected and corrected in these particular modes of operation.

Data reception and error analysis is accomplished completely in hardware whenever the test set is operating in Synchronous or Recovered Full Duplex mode and the DATA switch is set to any of the positions labeled as "PATTERNS." The action taken by the hardware circuitry upon a detected loss of sync depends upon the settings of two auxiliary functions. The available methods of handling a sync loss may be summarized as follows:

I. Autosync Mode

- A. Clear all accumulated error analysis results and automatically restart test upon reacquisition of sync, or
- B. Allow result accumulations to continue while receiver is in process of resynchronizing to incoming data, or
- C. Suspend result accumulations while receiver is in process of resynchronizing to incoming data.

II. Autosync Disable Mode

Allow result accumulations to continue after sync loss declaration and prevent receiver from attempting to resynchronize to incoming data. Autosync only after a complete BER interval with BER greater than or equal to 0.4 (4.00 E-1).

The Autosync Disable mode is selectable through Auxiliary Function 03, and sub-modes A, B, and C of the Autosync mode are selectable through Auxiliary Function 16.

The DATA SENTRY 10 is set at the factory to operate in sub-mode A of the Autosync mode. In this configuration a loss of receiver synchronization will cause all accumulated test results to be cleared and the test to be restarted. This sub-mode is useful when the user does not want the results of any test during which a sync loss occurred. Its disadvantage is that if a sync loss occurs after a long

period of testing, all of the results accumulated up to that point are lost (unless the test set is configured to provide a periodic results print).

In sub-mode B of the Autosync mode, the DATA SENTRY 10 does not stop the test when it loses sync but continues accumulating error counts indefinitely. Once its sync loss threshold is exceeded, the test set will immediately begin trying to reacquire sync. Due to the fact that error analysis continues even during the resynchronization process, sync losses are characterized by sudden "jumps" in the measured error count in this receiver configuration. In general, errors will be measured at a bit error rate of approximately 0.5 for the full duration of a sync loss. Thus the measurements of errors, error-free seconds, and seconds will give the user a good indication of what percentage of the received data was contaminated by sync losses and other errors.

Selecting sub-mode C of the receiver's Autosync mode causes the DATA SENTRY 10 to exclude from the test those received data segments contaminated by sync losses. As soon as a sync loss is detected the test set suspends all result accumulations until it resynchronizes to the incoming data. In the configuration, losses of sync due to a very high error rate or change in received data pattern result in a small, roughly fixed number of errors being counted. A complete data dropout results in no extra errors being counted. This is possible because a data dropout is declared when no data transitions have been detected at the input of the receiver for 20 bit periods. Thus a data dropout is recognized and error analysis halted well before the contaminated data reaches the output of the 50 bit delay (discussed in Section 5.3.8.2) where it is analyzed.

In Full Duplex operation, data reception and error analysis is accomplished in software whenever the test set is using Asynchronous Timing as well as whenever the DATA switch is set to any of the positions labeled as "MESSAGE". In software data analysis the user may configure the receiver to operate in the Autosync Disable mode or in submodes A or C of the Autosync mode. Operation of these modes is identical to that just described for hardware data analysis with the exception that the 50-bit data segment preceeding a sync loss may not be excluded from the test.

In all modes, the first detected sync loss after the start of a test will cause the SYNC LOST indicator to be illuminated. This indicator will remain lit until it is manually reset or the START/RESTART button is depressed, its purpose being to warn the operator that a sync loss has occurred since the test start. The SYNC LOST indicator is not affected by normal line turnaround in Half Duplex operation.

When the printer option is installed in the DATA SENTRY 10 or an external printer is connected to the unit, a printout will occur upon each sync loss stating "SYNC LOSS #N" followed by the time of occurrence, where N is the total number of sync losses that have occurred since the beginning of the test. The test set will also make an attempt to diagnose the cause of the sync loss. The causes listed at the beginning of this section will give rise to printouts of CLOCK LOST, DATA LOST, and FRAMING ERROR. If no data transitions occur over a time interval of 20 bit periods in the Synchronous or Recovered timing mode, a data loss will be declared. In all cases, SYNC ACQUIRED will be printed out, followed by the time, at the moment the test set comes back into synchronization with the incoming data.

5.3.9 Interpreting the Seconds Count

It is important to note that the positions of the DISPLAY I switch labeled "SEC" and "ERR FREE SEC" provide counts based on seconds of time during which error analysis was actually performed, which do not necessarily correspond to seconds of real time since the beginning of the test. Specifically, there are two cases in which the Seconds and Error Free Seconds counts (along with other error analysis results) are temporarily suspended during a test. One case is that in which the Data SENTRY 10 is configured to operate in Full Duplex Synchronous or Recovered mode with pseudorandom pattern data and a clock slip occurs. In this situation, the 50 bit segment of received data surrounding the clock slip is discarded from the test and all counts selectable through the DISPLAY I switch are suspended for the duration of this 50 bit segment.

The second case in which the Seconds and Error Free Seconds counts are suspended during the middle of a test is when the DATA SENTRY 10's receiver is configured to operate in sync mode IC (as defined in Section 5.3.8.3) and a sync loss occurs. In this case all counts selectable through the DISPLAY I switch are suspended for the duration of the sync loss. Note that the accumulation of results is suspended beginning 50 bit periods before the sync loss is declared.

In Half Duplex Single mode, the Seconds counter begins at the start of the test (START/RESTART depressed or RLSD On) and stops at the end of one complete transmit-receive cycle. In Half Duplex Continuous and Data Trap modes, the Seconds count indicates elapsed time since the beginning of the test.

5.3.10 Low Speed Operation

When using the DATA SENTRY 10 to perform error analysis on low speed data (about 200 bps or less), certain functional delays inherent in the test set begin to become apparent. Because the test set bases its determination of receiver synchronization and loss of synchronization on the analysis of a roughly fixed number of bits of received data, the time required to make these determinations increases as the data rate drops. At a data rate of 10 bps the user can expect the DATA SENTRY 10 to take approximately 4 seconds to declare synchronization to good data in the Synchronous and Recovered timing mode and approximately 9 seconds in the Asynchronous timing mode. These times will be longer if the received data contains errors or is the logical inversion of the data expected by the receiver.

In the Synchronous and Recovered timing modes, sync loss determinations are based on a larger number of received bits than "in sync" determinations and consequently take more time. At 10 bps a sync loss due to a change in received data type will be declared roughly 6 seconds after the data change occurs when the sync loss threshold is set at 32 errors in 128 or fewer bits. If in the manner described in Section 5.3.8.1 the sync loss threshold is increased to 240 errors in 1024 or fewer bits, the test set will not declare a loss of sync until approximately 50 seconds after the received data is no longer valid. In the Asynchronous timing mode at 10 bps, sync losses are always declared in about 9 seconds.

In the Synchronous and Recovered timing modes, data dropouts are declared when no transitions occur on the received

data line for 20 periods of the receiver clock and thus will always be flagged in 2 seconds or less. At all data rates, a loss of received clock is declared in under 200 milliseconds.

When the 50 bit received data delay discussed in Section 5.3.8.2 is active, all error analysis results are delayed by 50 bits. This means that at an operating speed of 10 bps errors in the received data will not be registered until 5 seconds after they actually occur. It should be noted, however, that the rear panel ERROR test point provides a real-time indication of the occurrence of errors in the received data as it is driven by a point in the circuit prior to the 50 bit delay. (Note that the ERROR test point operates only in Full Duplex Synchronous and Recovered Timing modes only.) The counts of Seconds and Error Free Seconds provided through DISPLAY I are also delayed by 50 bit periods when the data delay is active so as to maintain a proper time correspondence between these counts and the other available results. None of the results selectable through the DISPLAY I switch will begin to update until 50 bit periods after the IN SYNC indicator turns on.

5.3.11 Distortion Measurements

The only "long term" result available through DISPLAY II is the maximum value of telegraph distortion since the test start (the value displayed while the TEST MAX indicator is illuminated). All of the other results are free running in that new measurement intervals begin periodically independent of depression of the START/RESTART switch and old results are constantly being replaced by new results. It is important for the user to note that since the maximum value of telegraph distortion displayed is the largest value measured since the test start, one or two

misphased data transitions in the midst of a long test can make this result look very bad. It should also be noted that the circuit that measures telegraph distortion responds of necessity not only to data transitions but to any transitions in logic level occurring at the receiver's data input. This means that a noise spike on the received data interface line large enough to cross the threshold of the line receiver in the Data Interface will cause erroneous telegraph distortion measurements. Depending upon exactly where in the received data bit the noise spike occurs, it may or may not cause a bit error to be registered.

The DATA SENTRY 10 measures bias distortion on incoming data using a 201-step scale. These 201 steps correspond to 100% Space to 1% Space, 0% distortion, and 1% Mark to 100% Mark.

Since bias distortion is a measurement of the relative duration of a single Mark to that of a single Space, a true indication of bias distortion will only be obtained when the received data pattern contains an equal number of Marks and Spaces. For this reason it is best to use a 1:1 pattern for making bias distortion measurements. At higher data rates (above about 5 kbps) the pseudorandom patterns may also produce acceptable results. It should be recognized, however, that because the 63 bit pseudorandom pattern contains 32 marks and 31 spaces it has an inherent bias toward Mark of about 1.6%. The 511 pattern has an inherent bias of 0.2% toward Mark, and the 2047 and 4095 patterns have even less. It should also be noted that because the pseudorandom patterns have a lower transition density than the 1:1 pattern, bias distortion due to capacitive loading of the interface line and/or slowly transitioning data edges will not be as apparent when using pseudorandom pattern data.

5.3.12 Frequency Measurements

The frequency of the clock used to clock data out of the data generator is continuously measured in all operating modes. In the normal Asynchronous timing mode all data is transmitted through a USART that requires a clock at 16 times the desired output bit rate. The measured clock frequency is divided by 16 prior to being displayed in this timing mode so that the displayed value corresponds to the generated data rate in bits per second.

In the Synchronous and 1x Asynchronous timing modes the frequency of the clock accompanying the incoming data is continuously measured and may be displayed by selecting the "RCVR FREQ" position of the DISPLAY II switch. In the Recovered Timing mode the frequency of the recovered clock is measured and displayed. Note that this frequency may differ from the receiver frequency entered through the keyboard because the recovered clock is frequency-locked to the incoming data.

The resolution of the frequency measurement is equal to the inverse of the frequency measurement interval (FMI):

$$\text{Resolution (Hz)} = \frac{1}{\text{FMI (sec)}}$$

The accuracy of the frequency measurement is a function of the frequency measurement interval, the clock frequency, and the DATA SENTRY 10 timebase accuracy:

Accuracy (Hz) =

(clock frequency (Hz) x timebase

$$\text{accuracy}) + \frac{1}{\text{FMI (sec)}}$$

The measurement interval is normally one second, thus providing 1 Hz resolution. Auxiliary Function 18 allows this interval to be extended to 10 or 100 seconds to provide resolution of .1 or .01 Hz, respectively. The DATA SENTRY 10 employs a crystal oscillator timebase with an accuracy of .0035% (35 ppm) over the full rated temperature range of the test set. A high stability timebase is available as a customer option with an accuracy of .0007% (7 ppm). Table 5-4 shows some examples of frequency counter accuracy as a function of input frequency, measurement interval, and timebase accuracy.

5.3.13 Statistical Multiplexer Testing

Provision is made to allow the DATA SENTRY 10's data generator to respond to flow control signals from a statistical multiplexer (stat mux). Out-of-band flow control is available in all operating modes, and in-band flow control is available for Asynchronous operation in the Single Transmit and Full Duplex modes.

Out-of-band flow control makes use of the clear-to-send (CTS) signaling lead to regulate the output of Data Terminal Equipment connected to the statistical multiplexer. When the input buffer of the stat mux is nearing its maximum data capacity, the stat mux drops its CTS line and expects the DTE to stop transmitting within a specified number of characters.

Table 5-4. Frequency Counter Accuracy (Hz)

Measurement Interval	1 Sec		10 Sec		100 Sec	
Timebase Accuracy(%)	.0035	.0007	.0035	.0007	.0035	.0007
Frequency (Hz)						
10	1.0	1.0	.10	.10	.010	.010
100	1.0	1.0	.10	.10	.014	.011
1K	1.0	1.0	.14	.11	.045	.017
10K	1.4	1.1	.45	.17	.36	.08
100K	4.5	1.7	3.6	.80	3.5	.71
500K	19	4.5	18	3.6	18	3.5

When the stat mux again raises its CTS line sometime later, it expects the DTE to pick up data transmission exactly where it left off. The DATA SENTRY 10 will respond to the ON-OFF transition of the CTS signal by halting data transmission within one millisecond. The test set will resume its transmission exactly where it left off shortly after CTS is again turned on.

As an alternative to dropping the CTS signaling lead, a stat mux may instruct a DTE to halt transmission by inserting a special XOFF character into the data that it is transmitting to the DTE. The DATA SENTRY 10 has the capability of continually scanning the received data for this character and responding to its detection by ceasing transmission within two milliseconds. The test set will resume transmission upon the detection of an XON character in its received data,

this character being an indication from the stat mux that it is ready to accept more data.

Both the XON and XOFF characters are user programmable through Auxiliary Functions 34 and 35, respectively. Auxiliary Function 09 allows the inband flow control circuitry to be disabled to prevent the test set from accidentally entering flow control mode when not testing a stat mux system. This could occur when receiving character formatted pseudorandom data if the programmed XOFF character happened to appear as one of the characters.

5.3.14 Signaling Interaction

The signaling leads listed in Table 5-5 are implemented by the DATA SENTRY 10.

Table 5-5. Signaling Leads Implemented

<u>RS-232-C/V.24</u>	<u>RS-449</u>	<u>V.35/306</u>
DSR (data set ready)	DM	DSR
DTR (data terminal ready)	TR	DTR
RTS (request to send)	RS	RTS
CTS (clear to send)	CS	CTS
RLSD (received line signal detector)	RR	RLSD
RI (ring indicator)	IC	RI
SR/DTE (data signal rate selector/DTE source)	SR	--

On Data Interfaces of other types the nearest equivalent signaling leads are supported. In the following discussion, all signaling leads will be referred to by the RS-232-C designations.

When the unit is acting as a DTE, data transmission will normally not begin until the following conditions exist at the signal interface:

DSR - ON

*DTR - ON

*RTS - ON

CTS - ON

RLSD, RI, SR/DTE - don't care

The asterisks denote control signals originating in the test set. The states of these signaling leads are manually controlled through front panel switches in the Single Transmit and Full Duplex modes. In Half Duplex mode, the test set automatically takes over control of these leads in order to facilitate automatic line turnaround.

For cases in which the Data Communications Equipment to which the DATA SENTRY 10 is connected does not implement the DSR or CTS signaling leads, auxiliary functions may be used to internally set the state of either of these leads to ON or OFF. These auxiliary functions cause the test set to respond as if these signaling leads were in the states set, but do not cause the leads themselves to be driven.

When the test set is in the Emulate DCE mode, data transmission does not normally take place until the following conditions exist at the signal interface:

*DSR - ON

DTR - ON

*RLSD - ON

RTS, CTS, RI, SR/DTE - don't care

Here the asterisks denote control signals originating in the test set in DCE emulate mode. In all cases, the states of these signaling leads are manually controlled through front panel switches. Half Duplex testing is not allowed when the unit is emulating a DCE.

For cases in which the Data Terminal Equipment to which the DATA SENTRY 10 is connected does not support the DTR signaling lead, an auxiliary function may be used to internally set the state of this lead to ON or OFF. This auxiliary function cause the test set to respond as if this signaling lead was in the state set, but does not cause the lead itself to be driven.

Auxiliary Function 70 determines the line idling state for messages in Full Duplex Synchronous or Recovered mode. For all other modes when the test set is unable to transmit due to signaling conditions, the data line idles in the Mark state.

In the Half Duplex mode, "waiting" messages are displayed periodically on the center display to inform the user of the operating status of the DATA SENTRY 10. These messages indicate what signaling leads are preventing the test set from taking further action. These messages consist of two sequential parts, and are listed below.

First Part

GEN HLD
GEN HLD
GEN HLD
RCV HLD
RCV HLD

Second Part

DSR OFF
CTS OFF
RLS ON
DSR OFF
RLS OFF

SECTION 6

INSTRUMENT CHECKOUT

6.1 INTRODUCTION

This section describes the Automatic Self Test that the instrument performs at power-up. Also included is a Manual Self Test which can be used to verify proper operation of the DATA SENTRY 10. The following procedures assume that the user is familiar with the operation of the DATA SENTRY 10. Unfamiliar users should refer to Section 4.

6.2 AUTOMATIC SELF TEST

The Automatic Self Test is a series of diagnostic tests that are performed at power-up by the DATA SENTRY 10 to ensure that it is functioning correctly. If one of these tests fail, the DATA SENTRY 10 will display an Error Code, flash LEDs and Beep. The instrument should not be used if it fails any part of the Automatic Self Test.

The Automatic Self Test also performs the following functions which do not generate Error Codes:

- a. Writes asterisks to the alphanumeric displays.
- b. Activates the internal beeper.
- c. Checks for stuck switches. If a switch is found to be depressed at power up, the message "SWITCH STUCK" is displayed in the left-most and center display.
- d. The message "LOW LINE VOLTAGE" will also appear in the left-most and center display if the AC line voltage is between 45% and 80% of that required for proper operation.
- e. If the non-volatile RAM has failed, the message "NONV-RAM LOST" will be displayed in the left-most and center displays. This error condition means that all stored front panel setups and messages set by the user have been lost and that factory preset switch positions have been loaded into all the program locations. The time must also be reset. This condition will usually indicate that the battery needs replacing. The DATA SENTRY 10 is still fully functional though switch positions may not be saved through a power cycle.

6.3 MANUAL SELF TEST

6.3.1 Equipment Required

To perform the Manual Self Test, the following equipment is required:

- a. The DATA SENTRY 10 to be tested.
- b. One Data Interface.

6.3.2 Preparation

With the AC power off, plug the Data Interface into the Data Interface slot in

the rear of the unit. Verify that the line voltage selector card is set appropriately for the AC voltage source to be used.

6.3.3 Procedure

The following procedure should be performed in sequence because each step assumes the previous step's setup.

6.3.3.1 Power On

Press the PWR switch to the "ON" position and verify that the Automatic Self Test does not display any error codes in the left-most display. Also verify that several of the switch position LEDs are illuminated.

Set the DISPLAY/ENTRY switch to the "AUX" position, key in "99" and press the ENTER key. This clears all in-use auxiliary functions.

6.3.3.2 Frequency Synthesizer and Frequency Counter

Set the DATA SENTRY 10 switches to the positions listed in Table 6-1.

Verify that the right-most display reads "19200" and that the CLK ACT LED is on.

Change the DISPLAY II switch to the "GEN FREQ" position and verify that the right-most display reads "19200".

IF PROBLEM: To determine which circuit is at fault set the GEN CLK switch to the "BNC" position and place a known good clock into the EXT CLK IN BNC on the rear of the unit. If the right-most display reads the frequency of the clock source, then the Frequency Synthesizer may be defective. To determine this, connect a frequency counter to the GEN CLK OUT BNC on the rear of the unit and set the GEN CLK switch to the "SYNTH" position. If the synthesizer is operating properly, the frequency counter should read the same frequency that the Synthesizer is set to.

6.3.3.3 Synchronous Transmit and Receive

Set the switches listed in Table 6-2 to the indicated positions.

Table 6-1. Manual Self Test Switch Positions (6.3.3.2)

<u>Switch</u>	<u>Position</u>
MODE	"SELF LOOP"
DISPLAY/ENTRY	"SYNTH FREQ" 19200 Hz
TIMING	"SYNC"
GEN CLK	"SYNTH"
DISPLAY II	"RCVR FREQ"
RCVR FUNCTION	"ANALYZE"

Table 6-2. Manual Self Test Switch Positions (6.3.3.3)

<u>Switch</u>	<u>Position</u>
ERROR INSERT	"OFF"
DATA	"MK"
DISPLAY I	"ERRS"
BER INTVL	"10 ⁵ "

Press the START/RESTART switch and verify that the IN SYNC LED is illuminated and that a zero is displayed in the center display.

IF PROBLEM: If the IN SYNC LED is not on or errors are accumulating in the center display, re-check the setup and try another Data Interface.

6.3.3.4 Error Counter and Error Insert

Using the previous setup press the ERROR INSERT switch once and observe the center display increment by one count.

Adjust the AUDIO LEVEL control until a beep is heard every time the ERROR INSERT switch is pressed.

Hold down the ERROR INSERT switch until it enters the "10⁻³" position and observe the center display count incrementing rapidly. A beep should be heard for every second which contains an error.

Set the DISPLAY I switch to the "BER" position and verify the center display reads "1.0 E-3". A tone sequence should be heard every five seconds, indicating the end of a BER interval.

IF PROBLEM: Recheck the setup. Try a different Data Interface. Possibly a problem with Error Counter board or Error Insert circuitry.

6.3.3.5 Seconds and Blocks

Make the changes listed in Table 6-3 to the previous setup.

Press the START/RESTART switch and verify that the center display is incrementing one count per second. Step the DISPLAY I switch through the positions listed in Table 6-4 and verify these results.

6.3.3.6 Data Generator

Set the Synthesizer frequency to 10 Hz and verify that the MK LED is illuminated. Press the ERROR INSERT switch a few times and observe the SP LED is briefly illuminated.

Set the DATA switch to the "1:1" position and verify that the MK and SP LEDs are alternately illuminated.

Set the synthesizer frequency to 5000 Hz and sequence the DATA switch through all its PATTERNS positions and verify that the IN SYNC LED is illuminated for each position.

Table 6-3. Manual Self Test Switch Positions (6.3.3.5)

<u>Switch</u>	<u>Position</u>
DISPLAY/ENTRY	"SYNTH FREQ" 1000 Hz
DISPLAY I	"ERR FREE SEC"
ERROR INSERT	"OFF"
BER INTVL	"10 ³ "

Table 6-4. Manual Self Test Results (6.3.3.5)

<u>Position</u>	<u>Center Display</u>
"SEC"	Counting identical to "ERR FREE SEC"
"BLK ERRS"	Count of zero
"BLKS"	Counting identical to "ERR FREE SEC" and "SEC"

6.3.3.7 Distortion

Change the switch positions listed in Table 6-5.

Verify that the right-most display reads "99% MK" or "100% MK".

Change the Preamble to the values shown in Table 6-6 and verify that the right-most display reads the correct value plus or minus 1%.

IF PROBLEM: Try a different Data Interface. Possibly a fault in the Distortion circuitry.

6.3.3.8 Time

Set the DISPLAY II switch to the "TIME" position and verify that the correct time is displayed in the right-most display.

IF PROBLEM: Set the Time and Date as described in Section 4.6.5.1 and repeat the test.

Table 6-5. Manual Self Test Switch Positions (6.3.3.7)

<u>Switch</u>	<u>Position</u>
DATA	"PREAM ONLY"
DISPLAY II	"BIAS DIST"
DISPLAY/ENTRY	"PREAM" FF

Table 6-6. Manual Self Test Entry and Display (6.3.3.7)

<u>PREAM</u>	<u>Right-most Display</u>
F3	50% MK
F0	0%
03	50% SP
00	100% SP

6.3.3.9 Internal Printer

If an internal printer is installed, perform the setup listed in Table 6-7.

Press the CONTROLS PRINT switch once and verify that the printer prints the current position of each of the switches.

Set the PRINT EVENT switch to TEST INTVL and verify that a results print is initiated every 20 seconds.

IF PROBLEM: Check that the printer is not out of paper (the PAPER FEED switch illuminates to indicate this condition). Set the DISPLAY/ENTRY switch to the "AUX" position and key in "98" and press the ENTER key. This will clear the printer buffer.

Table 6-7. Manual Self Test Switch Positions (6.3.3.9)

<u>Switch</u>	<u>Position</u>
DATA	"4095"
BER INTVL	"10 ⁵ "

SECTION 7

PRINTER/CONTROLLER INTERFACES

7.1 INTRODUCTION

The DATA SENTRY 10 is capable of communicating with a wide variety of external devices including printers and controllers. The DATA SENTRY 10 comes equipped with an RS-232 Printer/Controller Interface, and both IEEE-488 and HP-IL Remote Control Interfaces are available as options. Although somewhat different in operating protocol and interface specifications, each of these interfaces provides the following capabilities:

- * Ability to output to an external printer.
- * Ability for an external device to remotely control the DATA SENTRY 10.
- * Ability for an external device to send data to the internal printer.

A 25 pin "D" connector located on the rear panel allows access to the RS-232 Printer/Controller Interface. A DIP switch located next to the connector allows interface parameters such as baud rate, parity, and the number of stop bits to be selected.

Both the IEEE-488 and HP-IL Remote Control Interface options consist of small plug-in modules which contain the appropriate connector and interface electronics. One of these modules may be installed through a slot in the rear panel.

7.1.1 Printer Selection

The DATA SENTRY 10 may have its internal printer installed, may be connected to an RS-232 external printer, and may have a printer communicating through the IEEE-488 or HP-IL interfaces. Auxiliary Function 11 and an auto-selection scheme are used to determine which printer(s) are to receive the DATA SENTRY 10's printed outputs.

Auxiliary Function 11 has four status selections:

- * NORM - the printer selection is performed automatically according to Table 7-1.
- * INT - the internal printer (only) is selected.
- * 232 - the external RS-232 printer (only) is selected.
- * REM - the external IEEE-488 or HP-IL printer (only) is selected.

Table 7-1 shows which printer or printers are automatically selected by the DATA SENTRY 10 when Auxiliary Function 11 is set to "NORM".

7.1.2 Controller Selection

Only one printer/controller interface may be recognized as the remote controller. After the DATA SENTRY 10 is powered-up or sent a device clear command

Table 7-1. Automatic Printer Selection

(Auxiliary Function 11 = NORM)

<u>Internal Printer</u>	<u>External RS-232 Printer</u>	<u>IEEE-488 or HP-IL Printer</u>	<u>Selected Printer(s)</u>
1	0	X	Internal printer (only) selected
0	1	X	External RS-232 printer (only) selected
1	1	X	Internal <u>and</u> external RS-232 printers selected
0	0	1	IEEE-488 or HP-IL printer selected

1 = Printer present (connected or installed)
 0 = Printer absent (not connected or installed)
 X = Don't care (may or may not be installed)

("CLEAR," or the IEEE-488 DCL or SCL commands), the RS-232 and IEEE-488 (or HP-IL) interfaces are examined for any sign of remote control. When one of these interfaces becomes active (reception of a valid command for RS-232 and HP-IL, MLA with REN true for IEEE-488), it is recognized as the remote controller. The other interface is ignored, and cannot assume remote controller status until after the next power-up or device clear.

The front panel REMOTE LED will be lit when the DATA SENTRY 10 is under remote control. The test set will remain under remote control until it receives the LOCAL or CLEAR commands (with RS-232 or HP-IL controllers) or the REN line is set false (IEEE-488 controller). While under remote control, the DATA SENTRY 10's front panel switches are disabled, except the DISPLAY I and DISPLAY II switches which can be disabled only by the DISPLAY command (see Table 7-4).

7.2 PRINTOUT FORMATS

This section describes the format of the printouts from the DATA SENTRY 10. Printed data is routed to the internal printer and/or the external printer interfaces as described in Section 7.1.1.

Printed data can occur in several basic formats. These formats include a standard results print, short results print, controls print, and miscellaneous status messages. These formats are described in the following sections.

7.2.1 Results Print

The results print consists of all the test results available at the time the print was initiated. The printout includes all displayable results and some printed-only results. A complete results print can be longer than 20 lines, although Auxiliary Function 10 makes a short print format available.

A typical long format error analysis results print is shown below:

```
23:59:58 31 JAN 84
BER          1.00E-3
ERRORS       632
BLOCKS       360
BLK LENGTH   P/M
BLK ERRS     390
SECONDS      76
EFS          11
CLK SLIPS    0
RCVR FRQ     9600Hz
GEN FRQ      9603Hz
TELEGRAPH DIST:
  MAX        12%E 15%L
  2 SEC      5%E  7%L
BIAS DIST    4% Mk
DELAY        1253ms
RS-232 INTERFACE
RTS :T DTR:T SR:F
CTS :T DSR:T RI:F
RLSD :T
RCVR DATA INVERTED
SELF LOOP
```

A typical long format "trap detected" results print is shown below:

```
14:30:01 24 MAR 86
TRAP SECS    3
GEN FRQ      2400Hz
TELEGRAPH DIST:
  MAX        16%E 9%L
  2 SEC      12%E 8%L
BIAS DIST    3%SP
DELAY        123ms
V.35 INTERFACE
RS:T DTR:T
CS:T DSR:T RI:F
RLSD:T
TRAP CHAR DETECTED
48 61 70 70 79 00
<< 33 30 >> 74 68
00 42 69 72 74 68
64 61 79 2C 00 42
6F 62 21 21
```

A typical short format "trap detected" results print is shown below:

A typical short format error analysis results print is shown below:

```
23:58:59 30 SEP 85
BER          1.00E-3
ERRORS       1499
BLOCKS       783
BLK LENGTH   P/M
BLK ERRS     732
SECONDS      167
EFS          11
CHAR ERRS    1499
PARITY ERRS> = 0
RCVR DATA INVERTED
SELF LOOP
```

```
23:58:59 25 APR 85
TRAP SECS    2
SELF LOOP
TRAP CHAR DETECTED
43 68 65 72 79 6C
00 << 69 73 >> 00
32 39 00 74 6F 64
61 79 21 21
```

7.2.2 Controls Print

A controls print lists the positions of most of the switches on the instrument, including the data interface and any installed options. It will also print which auxiliary functions are in use, whether the device is under local or remote control, and the status of most LEDs.

Switches which do not pertain to the ongoing test will not be available for printout. The mode of operation also determines which functions may or may not be printed.

Controls prints may be in long or short print formats, according to Auxiliary Function 10. A long format controls print can be longer than 40 lines, depending on the operating mode and on the number of auxiliary functions in use.

A typical long format controls print is shown below:

```
12:00:01 28 JUN 83
DATA:      2047
ERROR INSERT: OFF
MODE:      SELF LOOP
TIMING:    RECOV'D
GEN CLOCK: SYNTH
BER INTERVAL: 10+4
RCVR FUNC: ANALYZE
PRT EVT:   OFF
EMULATE:   DTE
RTS:T DTR:T SR:F
LOCAL:T REMOTE:F
SYNTH FRQ: 9600Hz
RCVR FRQ:  9600Hz
DELAY: DTR/ DSR/
PREAM:     FE 19
TRAP:      DATA
AUX IN USE:
01-AUDIO MON OFF
02-BEEP ACT  OFF
11-PRINTER   232
HDX DELAYS:
T1           0ms
T2           0ms
T3           0ms
XON CHARACTER: 0D
XOFF CHARACTER: 0A
L FRQ TH:    9590Hz
U FRQ TH:    9610Hz
BER ALARM THR: 3E-5
```

A typical short format controls print is shown below:

```
15:45:28 31 MAY 87
DATA      2047
ERROR INSERT: 10+3
MODE:     SELF LOOP
TIMING:    RECOV'D
GEN CLOCK: SYNTH
BER INTERVAL: 10+4
RCVR FUNC: ANALYZE
PRT EVT:   OFF
EMULATE:   DTE
RTS:T DTR:T SR:F
LOCAL:T REMOTE:F
SYNTH FRQ: 9600Hz
RCVR FRQ:  9600Hz
DELAY: DTR/ DSR/
PREAM:     FE 19
TRAP:      AC 20
AUX IN USE:T
```

7.2.3 Miscellaneous Printouts

The DATA SENTRY 10 provides a variety of other printouts, including status messages, signaling change printouts, and power-up printouts.

A "trap buffer full" message is printed when the PRINT EVENT switch is not set to "OFF" and all 255 characters have been received:

```
18:42:48 24 OCT 83
TRAP SECS      15
SELF LOOP
TRAP BUFFER FULL
55 5A (...) << 30
20 >> (...) 5A 55
```

A "2 minutes after trap" message is printed when the PRINT EVENT switch is not set to "OFF," and two minutes have passed since trap character detection without the trap buffer completely filling:

```
18:55:12 24 OCT 85
TRAP SECS      125
SELF LOOP
2 MIN AFTER TRAP
<< DATA >> 5A 5B 5C
```

After power-up, the following message will be printed if the PRINT EVENT switch is not set to "OFF":

```
POWER UP AT
12:01:59 31 JAN 85
LAST POWER DOWN AT
11:50:21 30 JAN 85
```

If Auxiliary Function 04 is set to "ON" (print on signaling change), the signaling change message may be printed:

```
23:58:59 31 MAR 88
SIGNALING CHANGE
RS-232 INTERFACE
RTS :T DTR:T  SR:F
CTS :T DSR:T  RI:T
RLSD :T
```

Some other miscellaneous status messages are shown below:

```
13:01:21 3 NOV 87
TEST RESTART
NEW CONFIGURATION
```

```
12:09:36 30 SEP 88
SYNC LOST      15
```

```
23:10:50 15 NOV 87
RCVR CLK LOST  121
```

```
23:15:10 15 NOV 87
SYNC ACQUIRED  122
```

```
BUFFER FULL
```

```
12:15:06 14 DEC 86
DATA LOST
```

7.3 GENERAL CONTROLLER COMMANDS

The DATA SENTRY 10 is able to respond to a variety of commands through the RS-232 Printer/ Controller Interface and the IEEE-488 or HP-IL Remote Control Interface. While there are specific commands which are associated only with one interface type, the majority of DATA SENTRY 10 commands are general in nature and can be implemented through any of the interfaces. The interface specific commands are addressed in later manual sections; the general controller commands are discussed in the following sections.

7.3.1 Command Format

Each command consists of a string (or strings) of ASCII characters which represent a command, a selected parameter, or a switch position selection. In some cases, the commands consists of a single character string (e.g. the "BEEP" command). In other cases, the command will consist of two character strings (e.g. the "DAT MK" command, where "DAT" represents the DATA switch, and "MK" represents the "MK" position of the DATA switch).

Except when operating in the Text Input mode (see "TEXT" in Table 7-4), all Space (20H) and Null (00H) characters are ignored, and all ASCII lowercase letters are converted automatically to upper case letters.

As characters are received, ASCII null characters are discarded and the remaining characters are placed in a buffer for storage until reception of a terminator. If the buffer fills before a

terminator is received, an Input Buffer Overflow flag is set and additional bytes received are discarded.

Reception of BS (backspace, 08H) causes the last received character to be ignored. Reception of CAN (cancel, 18H) will cause the current input line to be ignored. A new line may then be started.

The DATA SENTRY 10 uses a multiple terminator detection scheme whereby it is able to detect any one or combination of the following terminator sequences:

- a. CR
- b. LF
- c. CR, LF, or Space (20H) with the EOI line true (IEEE-488 only)

Once a terminator sequence is received, data is removed from the input buffer and analyzed. If the Input Buffer Overflow Flag is set, the data is discarded and an Input Buffer Overflow Error is generated.

If the character sequence removed from the buffer is unrecognizable, a Syntax Error is generated. Responses to the above error conditions are described in later sections. Provided that no error conditions occur, the character sequence is decoded, the appropriate response is generated, and the DATA SENTRY 10 prepares for another input sequence.

7.3.2 Switch Commands

Switch commands are used to select switch settings or enter information that normally would be entered through the DATA SENTRY 10 front panel. Front panel switch command words use mnemonics, which consist of the first three

letters of the switch name or switch position name, as found on the front panel. Numbers are not shortened or changed, although exponents are "lowered" to become the last digit of the number (e.g. "10⁻³" becomes "10-3").

To change a switch position, the switch name mnemonic is entered, followed by the desired switch position mnemonic. To enter information normally entered via the DISPLAY/ENTRY switch positions, only the switch position mnemonic and the information to be entered need be sent; the characters "DIS ENT" need not be sent first.

To obtain the current switch setting, only the switch name mnemonic is entered. The currently selected switch position will be sent to the selected printer.

Table 7-2 shows the switch mnemonics and the selectable switch position mnemonics. Table 7-3 shows the DISPLAY/ENTRY switch position mnemonics and the associated data entry formats.

The "AUX" command is the most complex of the switch commands. The format is "AUX nn xxxx," where "nn" is the access code of the desired auxiliary function and "xxxx" is the argument, which can take several forms. For status select functions, the argument is a two-to four-character string representing the desired status of that function. For short data entry functions, the argument is either a decimal number or a hex character representation.

Table 7-2. Switch and Switch Position Command Mnemonics

<u>Switch Name</u>	<u>Possible Positions</u>
DAT	MK, 1:1, 63, 511, 2047, 4095, PRE ONL, FOX, USE 1, USE 2, USE 3, USE 4
ERR INS	OFF, 10-3, SNG
MOD	SNG TX, FDX, HDX SNG, HDX CON, SEL LOO
TIM	SYN, ASY, REC
GEN CLK	BNC, SYN, INT
COD LEV	5, 6, 7, 8
PAR	EVE, ODD, NON
STO BIT	1, 1.5, 2
DIS I	ERR, BER (or BLK ANA), BLK, BLK ERR, SEC, ERR FRE SEC (or PRE MIS), CHA ERR, CLK SLI
BER INT	103, 104, 105, 106, 107, 108
DIS II	TEL DIS, BIA DIS, RCV FRE, GEN CLK FRE, DEL, AUD FRE, AUD LVL, TIM
RCV FUN	TRA, ANA
PRI EVE	OFF, 10 MIN, 30 MIN, 2 HRS, ERR SEC, TES INT
RTS (or CTS)	ON, OFF
DTR (or DSR)	ON, OFF
SR (or RLSD)	ON, OFF

Table 7-3. DISPLAY/ENTRY Switch Mnemonics and Entry Format

<u>Switch Name</u>	<u>Parameter Entry Format</u>
SYN FRE	nnnnnn , where "nnnnnn" is the desired frequency in hertz, 10.00 to 500000
RCV FRE	nnnnnn , where "nnnnnn" is the desired frequency in hertz, 10.00 to 500000
DEL	xxx a yyy b , where "xxx" is the start-of-measurement signal (DTR, DSR, RTS, CTS, CD, X, GA, or OUT), "yyy" is the end-of-measurement signal (DTR, DSR, RTS, CTS, CD, RCV, Y, or TRAP), "a" and "b" designate rising edge (/) or falling edge () selections
PRE	xx xx xx xx , where "xx" is a two-digit hex representation of a preamble character
TRA	xx xx xx xx , where "xx" is a two-digit hex representation of a trap character
PRO	For program recall: n, where "n" is the desired program number, 0 to 9 For program storage: AAA n , where "n" is the desired program, 0 to 9
AUX	nn xxxx , where "nn" is the access code of the desired auxiliary function (00 to 99), "xxxx" is the desired status of that function (see Section 4.6)

Long data entry arguments are a sequence of two-digit hex numbers which each represent a single character in a user message. For clarity, spaces may be left between each pair of hex digits. These spaces will be ignored by the DATA SENTRY 10.

The argument for special function auxiliary commands, such as the Real Time Clock Set, must have all the parameters entered as a single line entry:

AUX 60 HH:MM:, DD:MM:YY.

The command for the Trend 1-9-1 Message Download auxiliary function (see Section 4.6.5.4) is:

AUX 65 191 MSG

Menu-style auxiliary commands require all parameters to be entered on one line, with commas separating the parameters. Auxiliary Function 70 (SYN Character and Line Idle Selection), for example requires the form:

AUX 70 (CD LVL), (SYN), (SYN), (# SYN), (IDLE).

If a setup for code level 5, SYN characters set to 14 15, number of SYN characters set to 2 and idling character set to Mark were required, the sequence

AUX 70 5, 14, 15, 2, MK

would be sent.

The following switch commands are single character string commands, which cause the DATA SENTRY 10 to respond as if the corresponding front panel switch had been depressed and released:

<u>Command</u>	<u>Corresponding Switch</u>
STA RES	START/RESTART
DIS HOL	DISPLAY HOLD
SYN LOS	SYNC LOST
RES PRI	RESULTS PRINT
CON PRI	CONTRLS PRINT
PAP FEE	PAPER FEED
RLS LOS	RLSD LOST
ERROR	ERROR INSERT

7.3.3 Non-Switch Commands

The DATA SENTRY 10 responds to a number of commands which have no front panel equivalent. These commands are used to obtain information from the DATA SENTRY 10, or to modify the controller interface protocol. Table 7-4 lists these commands and the actions taken.

Table 7-4. Non-Switch Commands

HELP	- dump list of remote control commands and switch names to selected printer.
HELP command/switch	- dump list of the specified command's parameters or the specified switch's positions to selected printer.
REMOTE	- enter remote mode.
LOCAL	- enter local mode.
CLEAR	- execute a device clear.
BEEP	- sound beeper once.
FORMAT	- format all outputs with spaces.
UNFORMAT	- delete spaces from all outputs.
ENTER	- receive commands but do not process. Allows setting switches temporarily in contention without getting an error message.
END	- process commands received since ENTER.
SRQ (ALL, ERROR)	- enables service request on all outputs or on errors only (IEEE-488 or HP-IL only). The "ALL" setting is assumed on power-up.
ECHO (ON, OFF)	- enables or disables character echo (232 mode only). The "OFF" setting is assumed on power-up.
PROMPT (ON, OFF)	- enables or disables RS-232 prompt feature. The "OFF" setting is assumed on power-up.
TERM HP-IL (CR, CRLF)	- terminate all HP-IL outputs lines with a carriage return or a carriage return and linefeed. The HP-IL terminator selection is stored with the power off.

Table 7-4. Non-Switch Commands (Cont.)

TERM 488 (CR, CRLF)	- override the DIP switch setting and terminate all IEEE-488 outputs with a carriage return or a carriage return and linefeed. Upon power-up, the DIP switch setting determines the IEEE-488 terminator.
TERM 232 (CR, CRLF)	- override the DIP switch setting and terminate all RS-232 outputs with a carriage return or a carriage return and linefeed. Upon power-up, the DIP switch setting determines the RS-232 terminator.
TEXT	- all subsequently received characters are sent to the selected printer until an ETB (17H) is received. Note that no characters are modified or deleted in this mode.
HOLD	- hold printer output buffer outputs.
REL	- release printer output buffer outputs.
CONTROLS	- clear printer output buffer and execute a CONTROLS PRINT as a single function.
TERMINAL	- sets the DATA SENTRY 10 to talk to an RS-232 terminal by setting PROMPT ON, ECHO ON, and TERM 232 to CRLF. Also sets Auxiliary Function 11 to "232".
STATUS	- dump remote control status to selected printer (i.e. status of PROMPT, ECHO, TERM 232, TERM 488, TERM HP-IL).
MESSAGE 1	- All subsequently received characters are placed in the USER 1 message memory. This command has the same function as Auxiliary Function 41, except that characters can be entered directly in ASCII instead of hexencoded ASCII. To terminate this mode, ETB (17H) must be received, indicating the end of the message.

Table 7-4. Non-Switch Commands (Cont.)

MESSAGE 2, MESSAGE 3, & MESSAGE 4	- same as MESSAGE 1 except characters are placed in USER 2, USER 3, or USER 4, respectively.
DISPLAY (LOCAL, REMOTE)	- enables ("LOCAL") or disables ("REMOTE") front panel control of the DISPLAY I and DISPLAY II switches while the DATA SENTRY 10 is under remote control. The "LOCAL" position is assumed on power-up.

7.4 RS-232 PRINTER/CONTROLLER INTERFACE

The RS-232 Printer/Controller Interface is provided as a standard feature of the DATA SENTRY 10. The female 25-pin D-subminiature connector and a DIP switch are located on the rear panel of the instrument for interconnection and parameter selection.

The RS-232 Printer/Controller Interface is configured such that the DATA SENTRY 10 acts as Data Terminal Equipment (DTE) and may be directly connected to Data Communications Equipment (DCE). This allows direct connection to modems with RS-232 interfaces. All communication is performed using 7-bit ASCII with parity.

7.4.1 Switch Settings and Connector Pinouts

The rear panel DIP switch has eight switches numbered from "1" to "8". Table 7-5 summarizes the function and settings of the DIP switch.

The 25-pin D-subminiature connector pin assignments are given in Table 7-6. The RS-232 Printer/Controller Interface is configured as a DTE and can be directly connected to a modem. An adaptor cable is available to allow connections to other DTE devices.

7.4.2 Input Sequence

A typical controller input sequence would occur as follows:

1. The controller sends the DATA SENTRY 10 an ASCII character which is the first part of a command sequence. Upon reception of this character, the DATA SENTRY 10 automatically executes a temporary printer HOLD command. This command halts any ongoing printer outputs at the end of the outgoing line. Data may continue accumulating in the printer buffer but no data will leave the buffer until a command terminator is received by the DATA SENTRY 10.
2. The DATA SENTRY 10 takes the received character and places it in its input buffer. If the ECHO function is enabled, the character is placed in an auxiliary output register in preparation for output.
3. Additional non-terminator characters are received. Null characters are discarded as they are received. All other characters except Backspace (BS) and Cancel (CAN) are placed in the input buffer for storage until a terminator is received. Each received Backspace character causes the last character entered into the input buffer to be discarded. Cancel (also known as Control X) causes the entire input line to be discarded and the input buffer overflow flag to be cleared. If the input buffer overflows before a terminator is received the Input Buffer Overflow flag is set.

If the ECHO function is enabled each printable character is placed in an auxiliary output register in preparation for output. All control characters (other than CR, LF, BS, CAN) are echoed as a period (2C H). This allows a terminal operator to see a control character represented on the screen as a dot and to use the

Table 7-5. RS-232 Printer/Controller Interface DIP Switch

S1, S2 Baud Rate Select		
<u>S1</u>	<u>S2</u>	<u>Baud Rate</u>
down	down	150
up	down	300
down	up	1200
up	up	2400
S3 Parity Select		up = Even parity down = Odd parity
S4 Number of Stop Bits		up = 2 stop bits down = 1 stop bit
S5 Terminator Character		up = CR down = CR-LF
S6, S7, S8 Not used		

Table 7-6. RS-232 Printer/Controller Interface Pinouts

<u>Pin</u>	<u>Abbrev.</u>	<u>Name</u>	<u>Comments</u>
1	-	Protective Ground	
2	TD	Transmit Data	output from DATA SENTRY 10
3	RD	Receive Data	input to DATA SENTRY 10
4	RTS	Request to Send	held ON (true) whenever power is on
5	CTS	Clear to Send	must be ON (true) for DATA SENTRY 10 to transmit data
6	DSR	Data Set Ready	must be ON (true) before DATA SENTRY 10 will respond to any other signaling
7	-	Signal Ground	
8	RLSD	Receive Line Signal Detector	must be ON (true) before DATA SENTRY 10 will accept any data
20	DTR	Data Terminal Ready	held ON (true) whenever power is on
22	RI	Ring Indicator	received; reserved for future use

backspace key to eliminate it or previous entries. When the DATA SENTRY 10 receives a BS, provided that there is data in the input buffer, the BS will be echoed and the most recently input character will be discarded. Upon reception of a Control X (CAN), the current input line will be discarded and a terminator sequence echoed.

4. The controller sends the DATA SENTRY 10 one or both of the following terminators:
 - a. CR
 - b. LF
5. The DATA SENTRY 10 recognizes that a terminator has been received and processes the command.

If the PROMPT or ECHO function is enabled, the output terminator (CR or CR LF) is placed in the auxiliary output buffer as a terminator response. Note that if the the input terminator is the same as the selected output terminator then this action is equivalent to echoing the terminator character. Otherwise, it is equivalent to echoing a modified terminator which is useful with terminals which send CR terminators but need to receive CR LF terminators.

Upon terminator reception, the DATA SENTRY 10 analyzes the data in its input buffer. If an input overrun (i.e. a byte was overwritten in the UART), parity error, framing error, input buffer overflow, contention, or syntax error is detected, the appropriate fault message is loaded into the auxiliary output register. If no faults are detected, the DATA SENTRY 10 decodes the command and responds appropriately.

If a contention fault is detected, the switch position will be selected and the contending switch name will be loaded in the auxiliary output buffer.

If the PROMPT feature is enabled, the prompt character (a ">" (3E H)) is loaded into the end of the auxiliary output buffer. This character will be the last out of the auxiliary output register. It signifies that the command sequence has been received and processed, that any fault messages associated with that command have been sent, and that the DATA SENTRY 10 is ready for additional commands.

Some controllers may not be capable of watching for the prompt character to determine when the DATA SENTRY 10 is prepared to accept additional commands. After sending a terminator following a command sequence, these controllers should wait long enough to verify that the DATA SENTRY 10 data outputs are completed (i.e. no fault messages are forthcoming) before sending additional commands. The purpose of having the controller wait for a prompt, or to wait long enough to assure that the DATA SENTRY 10 is ready, is to prevent auxiliary output buffer overflows. If the DATA SENTRY 10 receives an additional command before its auxiliary output buffer is empty, the buffer contents may be overwritten with new echoed characters, prompts, or fault messages. Thus, fault messages could be lost or associated with the wrong command. If the auxiliary output buffer does overflow, the string "OVF" will be imbedded in the auxiliary output data.

7.4.3 Output Sequence

Outputs can be divided into two categories - those which pass through the printer buffer and those which come from the auxiliary output buffer.

Data output from the printer buffer will occur whenever the buffer contains data, no HOLD command has been issued, and the CTS line is in the ON (true) condition. The outputs will continue sequentially until one of the above conditions is not true. If the CTS input turns OFF (false) during an output, the output will stop and eventually resume when the CTS goes ON again. If the HOLD command is received, the output will stop after the next sequential terminator is output. Once the REL command is received, the output will resume where it left off.

When characters are received through the RS-232 Printer/Controller Interface, a temporary Hold command is automatically executed. An output from the auxiliary output buffer will occur if the ECHO or PROMPT features are enabled or if a fault message is generated. For the output to start, the CTS line must be ON and any ongoing printer output must have stopped. Once the auxiliary output buffer is empty, the output is complete and normal printer outputs may continue.

7.4.4 Fault Messages

The fault messages take the form "FAULT XXX" and are terminated by a carriage return or carriage return and linefeed, as selected. The possible fault codes are:

SYN - command syntax error
OVF - command overflow error
OVR - UART input overrun error
PAR - UART input parity error
FRA - UART input framing error
CON - switch contention

The switch contention fault code is followed by a list of the contending switches.

7.5 IEEE-488 REMOTE CONTROL INTERFACE (Option 40336)

The DATA SENTRY 10 IEEE-488 Remote Control Interface is designed to comply with the IEEE Standard 488-1978. The IEEE-488 interface is installed in the rear panel of the DATA SENTRY 10 and can be connected with up to 14 other devices at once.

The IEEE-488 Remote Control Interface has two basic modes of operation: Talk Only and Addressable modes. In the Talk Only mode, the DATA SENTRY 10 is designed to directly drive a Listen Only device such as a printer. In this mode, the DATA SENTRY 10 can only output data and cannot receive commands or be remotely controlled. In Addressable mode, the DATA SENTRY 10 should be connected to the IEEE-488 bus along with a controller. Other Addressable or Listen Only devices may be connected to the bus if desired. In this mode, the controller may address the DATA SENTRY 10 to "listen" and receive commands, or it may address the DATA SENTRY 10 to "talk" and send data outputs.

7.5.1 Switch Settings and Mode Selection

The operating mode of the interface is determined by the setting of a DIP switch located next to the connector on the interface panel. The Talk Only mode is selected by setting switch #6 down, and the Addressable mode is selected by setting switch #6 up.

In the Talk Only mode, the DATA SENTRY 10 is designed to drive a Listen Only device. The DATA SENTRY 10 should be directly connected to the device, with no other Controllers or

Talkers connected to the bus. The printer or other device must be set for continuous listening.

Each time the DATA SENTRY 10 has data in its output buffer, data transfer to the listener will start. Data is transferred character by character, with each line of data consisting of 20 or fewer ASCII characters followed by a Carriage Return (CR) with or without a Linefeed (LF). Data transfer will continue until the printer buffer is empty.

In Addressable Mode, each device connected to the bus is assigned either a talk address, listen address or both. The DATA SENTRY 10 talk and listen addresses are selected by the DIP switch on the interface. The five least significant bits of the address, labeled "1" through "5", are set with these switches, and the two most significant bits are automatically set to 01 or 10 for the talk and listen addresses, respectively.

In Addressable Mode, the DATA SENTRY 10 is capable of local (front panel) or remote (via the bus) control. When not in remote mode, the DATA SENTRY 10 operates under local control. In this mode, the controller can address the DATA SENTRY 10 to talk and thus obtain data. It may also send the DATA SENTRY 10 a limited number of general purpose commands defined in the IEEE-488 specification.

The DATA SENTRY 10 is placed under remote control when it is addressed to listen while the REN line is driven true. When under remote control, the controller may change any or all of the operating parameters by sending commands consisting of ASCII characters to the DATA SENTRY 10. In addition to front panel

parameter selection, remote control operation allows a number of commands to be executed which have no front panel switch equivalent; it also allows the same data output capabilities provided during local operation.

If the REN line goes false at any time during remote operation, the DATA SENTRY 10 will automatically revert to local operation.

7.5.2 IEEE-488 Commands

The various commands accepted by the DATA SENTRY 10 can be divided into two categories: Command Mode commands and Data Mode commands. Command Mode commands are defined in the IEEE-488 specification. These commands are issued by the controller with the Attention (ATN) line held in the true condition to signify the Command Mode.

These commands serve several purposes:

1. Talk and listen addresses select the instruments that will source and accept data. Since the DATA SENTRY 10 is capable of both talking and listening, it monitors all addresses sent over the data bus and responds appropriately when it recognizes its address.
2. Universal commands cause every instrument so equipped to perform a specific interface operation. These include five multiline commands (i.e. commands sent over the data bus) and four uniline commands.
3. Addressed commands are similar to universal commands except that they affect only those devices that are addressed. These are all multiline commands.

Table 7-7 defines the DATA SENTRY 10's response to a variety of Command Mode commands.

Data Mode commands are not defined by the IEEE-488 specification. These commands are used to instruct the DATA SENTRY 10 to perform device-dependent functions such as changing a switch setting. These commands are issued by the controller with the ATN line in the false state to signify Data Mode. Section 7.3 defines the DATA SENTRY 10 general controller commands, which constitute the Data Mode commands. Each of these commands starts with a string of ASCII characters which signifies the parameter to be selected or the command's primary function. In some cases, this first character string will be the entire command (e.g. the "BEEP" command). In other cases, the first character string will be followed by a second character string to specify the value to be selected (e.g. the "MK" portion of the "DAT MK" command). In all cases, extra space or null characters may be added into a character string since these are ignored by the DATA SENTRY 10.

7.5.3 Input Sequence

A typical input sequence consists of the following:

1. The controller addresses the DATA SENTRY 10 to listen.

Table 7-7. IEEE-488 Command Mode Commands

Uniline Commands:

ATN (attention) - true = command mode
false = data mode

DAV, DAC, RFD (data available, data accepted, ready for data)
- handshaking signals for byte transfers.

IFC (interface clear) - return all IEEE-488 interface functions to an idle state.

REN (remote enable) - This line determines the source of input information.
When it is false, the front panel switches control the DATA SENTRY 10.
When it is true and the DATA SENTRY 10 receives MLA, the switches are ignored and the remote controller is the source of input information.

Commands Requiring Software Action:

DAB (data byte) - Data is only accepted when the remote line is true.

DCL, SDC (device clear) - reset the DATA SENTRY 10 to a power-on state.

GET(group execute trigger) - initiate a test restart. This is equivalent to pressing the START/RESTART front panel switch.

SRQ/STB (service request with status byte) - transmitted by the DATA SENTRY 10 when either data is ready to transmit or an error condition has occurred. An error condition must be acknowledged by a serial poll before data transfers can continue.

Transparent Commands:

ACG (addressed command group)

GTL(go to local) - causes control to be returned to the front panel control switch.

UCG (universal command group)

SPE (serial poll enable) - status byte will be output upon reception of MTA.

SPD (serial poll disable) - disable SPE function above.

Table 7-7. IEEE-488 Command Mode Commands (Cont.)

LAG (listen address group)

MLA (my listen address) - begin receiving data bytes.

UNL (unlisten) - end receiving data bytes.

TAG (talk address group)

MTA (my talk address) - begin transmitting data bytes.

OTA, UNT (other talk address, untalk) - stop transmitting data bytes.

Unimplemented Commands:

LLO(local lockout) - no "return to local" switch on front panel.

MSA, OSA (my secondary address, other secondary address) - no extended addressing supported.

PPC, PPE, PPD, PPU, PPRN (parallel poll configure, enable, disable, unconfigure, response N) - no parallel poll supported.

IDY = ATN*EOI (parallel poll) - not supported.

TCT (take control) - no controller capability.

2. The controller sends a Data Mode command.
3. The controller sends a terminator.
4. Upon receipt of the terminator, the DATA SENTRY 10 analyzes the command and responds appropriately.

As characters are received, ASCII null characters are discarded and the remaining characters are placed in a buffer for storage until reception of a terminator. If the buffer fills before a terminator is received, an Input Buffer Overflow flag is set and additional bytes received are discarded.

Reception of a backspace (BS, 08H) will cause the last character input to be ignored. Reception of a Control X (CAN, 18H) will cause the current input line to be ignored. A new line may then be started.

The DATA SENTRY 10 uses a multiple terminator detection scheme whereby it is able to detect any one or combination of the following terminator sequences:

- a. CR.
- b. LF.
- c. CR, LF, or Space (20H) with the EOI line true.

Once a terminator sequence is received, data is removed from the input buffer and analyzed. If the Input Buffer Overflow Flag is set, the data is discarded and an Input Buffer Overflow Error is generated. Spaces in the input buffer are ignored in command decoding.

If the character sequence removed from the buffer is unrecognizable, a Syntax Error is generated. Error conditions are flagged in the Serial Poll Status Byte described in Section 7.5.5. Provided that no error conditions occur, the character sequence is decoded, the appropriate response is generated and the DATA SENTRY 10 prepares for another input sequence.

7.5.4 Output Control

Data (measurement results, control settings, and instrument status) outputs are initiated according to the front panel controls and auxiliary print commands. Since the controller has complete control over all front panel controls and auxiliary print commands, a variety of possibilities exist. Some examples are:

- a. The controller sets the PRINT EVENT switch to the "OFF" position. The controller may then issue a RES PRI or CON PRI command (corresponding to pressing RESULTS PRINT or CONTROLS PRINT) to initiate a data output whenever it desires data.
- b. The controller sets the PRINT EVENT switch to the "ERR SEC," "10 MIN," "30 MIN," "2 HRS," "TEST INTVL," or "ERR SEC" position. Now a results output will be initiated on the occurrence of the selected event.

Additionally, since the PRINT EVENT switch is not in the "OFF" position, status change outputs such as sync loss and clock loss messages will be initiated on their occurrence. Results and controls prints may also be initiated by the controller at any time.

7.5.5 Output Sequence

A Data Mode command allows the user to select one of two output modes:

- * Output Mode 1 ("SRQ ALL") - A Service Request is generated by the DATA SENTRY 10 each time new data is available for output, or when an input error condition is detected.
- * Output Mode 2 ("SRQ ERROR") - A Service Request is generated only when an error condition is detected.

A typical output sequence for Output Mode 1 would be as follows:

1. When the DATA SENTRY 10 gets data in its output buffer, it initiates a service request by asserting the SRQ line.
2. The controller responds to the service request by sending a Serial Poll Enable command, which establishes the serial poll mode for all responding talker devices on the bus. Next, the controller sequentially addresses each device on the bus which could be asserting the SRQ line. Each responding device outputs an eight bit status byte which lets the controller know if it was the device requesting service.
3. When the DATA SENTRY 10 is addressed to talk, it releases the SRQ line and outputs a status byte. The controller examines the status byte and determines that the DATA SENTRY 10 was the device requesting service, that it has new data

to output, and that it has not detected any error conditions. Table 7-8 shows the Serial Poll status byte format.

4. The controller then sends Serial Poll Disable and Untalk commands to terminate the serial poll mode. Finally, the controller addresses the DATA SENTRY 10 to talk.
5. The DATA SENTRY 10 outputs its data with a carriage return and optional linefeed character at the end of each line with the EOI line asserted.

A similar sequence to the one described above would occur if the DATA SENTRY 10 detected an Input Buffer Overflow or Syntax Error. In this case, the controller performs the serial poll, obtains the DATA SENTRY 10 status byte, and determines that an error condition exists. It then disables the serial poll mode and takes appropriate action to correct the error condition.

A typical output sequence for Output Mode 2 would be as follows:

1. The controller periodically addresses the DATA SENTRY 10 to talk.
2. If output data is available, then it will be sent to the controller.
3. The terminator character(s) will be transmitted with the EOI line asserted following the final output.
4. The controller times out if the DATA SENTRY 10 stops transmitting data.

Table 7-8. Serial Poll Status Byte

<u>B7</u>	<u>B6</u>	<u>B5</u>	<u>B4</u>	<u>B3</u>	<u>B2</u>	<u>B1</u>	<u>B0</u>
	rsv			dat	ovf	con	syn
dat = new data available rsv = request service ovf = command buffer overflow error syn = command syntax error *con = switch contention (invalid setup)							
* The contending switch labels will be placed in the print buffer to be read out by the controller.							

7.5.6 Installation and Removal

This section provides detailed instructions for installing or removing the interface. The IEEE-488 Remote Control Option (Model 40336) kit consists of:

1. IEEE-488 module assembly
(PL 40336-01) Qty 1
2. Pan head machine screw, #6 x 3/8"
Lg Qty 2

7.5.6.1 Installation Procedure

The following procedure should be followed when installing the IEEE-488 Remote Control Option:

1. Remove the power source.

CAUTION

The power must be OFF when installing or removing the IEEE-488 option. Equipment damage may occur if the power is ON during installation or removal.

2. Remove the top cover. The top cover is held by two screws securing the top rear extrusion to the rear panel. Remove and save these two screws and slide the extrusion and top rearward. Remove blankoff plate if installed.
3. Insert the IEEE-488 module Assembly carefully through the rear panel

opening. Visually align the card edge connector with the mating connector located on the vertical printed circuit board. When the connector is properly engaged, the IEEE-488 panel will be flush against the DATA SENTRY 10 rear panel, and the mounting holes will line up.

4. Install the two #6 screws at both ends of the IEEE-488 panel, securing it in place.
5. Slide the top cover in place and install the two screws that secure the rear extrusion to the rear panel.

7.5.6.2 Removal Procedure

To remove the IEEE-488 Remote Control Option:

1. Remove the power source.
2. Remove the IEEE-488 module assembly by grasping firmly, disengaging the connector, and carefully removing through the rear panel opening.

7.6 HP-IL REMOTE CONTROL INTERFACE (OPTION 40338)

The DATA SENTRY 10 HP-IL Remote Control Interface is designed to comply with the Hewlett Packard Publication The HP-IL Interface Specification dated November 1982. The HP-IL interface is installed in the rear of the DATA SENTRY 10 in the same slot used by the IEEE-488 interface. The interface is similar to the IEEE-488 interface, except all commands and data are sent around a two wire transformer-coupled loop. The HP-IL Remote Control Interface allows the DATA SENTRY 10 to be connected to up to 30 other HP-IL devices. These devices can be HP-41CV calculators, computers with HP-IL interfaces, printers, or cassette recorders.

The DATA SENTRY 10 HP-IL Remote Control Interface requires that at least one of the instruments on the loop be an HP-IL controller. The controller must assign addresses and talker/listener status before data can be exchanged between devices on the loop. If data is to be sent from the DATA SENTRY 10 to an HP-IL printer, the HP-IL controller would assign the DATA SENTRY 10 as the talker and the HP-IL printer as the listener and allow them to communicate directly. The HP-IL controller can also change the DATA SENTRY 10 front panel switch settings by sending commands described in Section 7-3.

7.6.1 HP-IL Commands

The commands used with the HP-IL Interface can be broken down into four categories: Command Mode commands, Ready Group commands, Identify Group commands, and Data Mode commands. Command Mode, Ready Group, and

Identify Group commands are defined by the HP-IL specification. Table 7-9 describes the DATA SENTRY 10 HP-IL Remote Control Interface's response to each of the Command Mode, Ready Group, and Identify Group commands.

Data Mode commands are not defined by the HP-IL specification. These commands instruct the DATA SENTRY 10 to perform device-dependent functions such as changing particular switch settings.

Section 7.3 defines the DATA SENTRY 10 general controller commands, which constitute the Data Mode commands. These are the same commands used with the RS-232 and IEEE-488 interfaces.

7.6.2 Input Sequence

A typical input sequence consists of the following:

1. The controller assigns the DATA SENTRY 10 an address.
2. The controller addresses the DATA SENTRY 10 to listen.
3. The controller sends a Selective Device Clear which stops the DATA SENTRY 10 from sending any more data to the HP-IL interface.
4. The controller checks the status byte to make sure there is no data in the HP-IL interface that should be read before sending a command.

Table 7-9. Response to HP-IL Commands

HP-IL Message	DATA SENTRY 10 Response
COMMAND GROUP	
Interface Clear	Talker or listener status removed and pending addressable message cleared.
Device Clear	Executes a "HOLD" command.
Selected Device Clear	Executes a "HOLD" command.
Go To Local	No response.
Local Lockout	No response.
Remote Enable	No response.
Not Remote Enable	No response.
Parallel Poll Enable 0-15	If listener and not already parallel poll enabled, set to modify subsequent identify messages according to parallel poll conventions.
Parallel Poll Disable	If listener, set to not modify subsequent identify messages.
Parallel Poll Unconfigure	Set to not modify subsequent identify messages.
Group Execute Trigger	No response.
Loop Power Down	No response.
Enable Asynchronous Requests	No response.
Auto Address Unconfigure	Address set to 4.
Listen Address 0-31	If address matches,* data for HP-IL cleared from transfer buffer, device removed from talker status, and device becomes a listener. If address is 31, device removed from listener status.
Unlisten	Device removed from listener status.

Table 7-9. Responses to HP-IL Commands (Cont.)

HP-IL Message	DATA SENTRY 10 Response
Talk Address 0-31	If address matches,* device removed from listener status and becomes a talker. If address doesn't match, device removed from talker status.
Untalk	Device removed from talker status.
Secondary Address 0-30	Following addressed message, if primary and secondary addresses match device's extended address, device responds to message.
Null	No response.
READY GROUP	
Take Control	If talker, the response is not defined. (Operation as a controller not supported).+
Ready For Command	Executes a pending Loop Power Down message.
Send Data	If talker, begins sending contents of transfer buffer or control register as selected.+
Send Status	If talker, sends one byte of status.
Send Device ID	If talker, sends eight ASCII-coded bytes: HP82166A.+
Send Accessory ID	If talker, sends one byte with the value 64.+
Not Ready For Data	If talker, makes previous data byte the last byte sent.
End Of Transmission--OK	No response.
End Of Transmission--Error	If talker, sent immediately for bad HP-IL error check.
Auto Address 0-31	If device has earlier assigned address, no response. If address is 31, no response.

Table 7-9. Responses to HP-IL Commands (Cont.)

HP-IL Message	DATA SENTRY 10 Response
	If message address less than 31 and device doesn't have earlier assigned address, device address set to message address increments message address one, and passes revised message.
Auto Extended Primary 0-31	If device has earlier assigned address, no response. If address is 31, no response. If not preceded by Auto Extended Secondary message, no response. If preceded by Auto Extended Second 31, no response. If preceded by Auto Extended Secondary less than 31, if message address less than 31, and if device doesn't have earlier assigned address, then device address set to primary and secondary addresses just received.
Auto Extended Secondary 0-31	If device has earlier assigned address, no response. If address is 31, no response. If message address less than 31 and device doesn't have earlier assigned address, device secondary address set to message address, increments message address by one, and passes revised message. (Must be followed by Auto Extended Primary message to establish valid device address.)
Auto Multiple Primary 0-31	No response.
IDENTIFY GROUP	
Identify (no service request)	If device set to respond by Parallel.
Identify (service request)	Poll Enable message, modifies message according to parallel poll setup and service request status.

Table 7-9. Responses to HP-IL Commands (Cont.)

HP-IL Message	DATA SENTRY 10 Response
DATA GROUP	
Data Byte (no service request)	If talker, sends next data byte.+
Data Byte (service request)	If listener, accepts data byte and passes to next device. If service required by converter, modifies message to Data Byte (service request).
End Byte (no service request)	If talker, sends next data byte.+
End Byte (service request)	If listener, accepts data byte and passes to next device. If service required by converter, modifies message to End Byte (service request).
* For extended addressing, the message address must match the primary address. The response occurs only if the correct Secondary Address message follows. + Indicates that the received message is not passed to the next device in the loop.	

5. The controller sends a Data Mode command.
6. The controller sends a terminator.
7. Upon receipt of the terminator, the DATA SENTRY 10 analyzes the command and responds appropriately.

HP-IL is designed so that addresses are assigned automatically by the controller, therefore, a DIP switch is not required on the interface to perform this function. The addresses are assigned beginning with "1" which is assigned to the first device to receive the Auto Address command. This device increments the address and sends it to the second device on the loop. This continues around the loop until the Auto Address command is returned to the controller.

The controller can determine what a particular device on the loop is by sending the Send Device ID Ready Group command. The DATA SENTRY 10 will respond to this by sending the character string "HP82166A."

The Status Byte described in Table 7-10 contains the current status of the DATA SENTRY 10's HP-IL interface. If the Status Byte is not checked before sending a command to the DATA SENTRY 10, any data that is in the interface at that time will be lost. This is true because the HP-IL interface has a 32 byte FIFO in it. This FIFO can only send data in one direction at a time and must be emptied before data is sent in the other direction.

The implementation of the Device Clear Command Group command has been designed to partially alleviate this problem.

Upon reception of this command, the DATA SENTRY 10 will execute a temporary HOLD command and stop putting data into the interface until it receives an input terminator from the controller and is again addressed to talk. This will alleviate the problem where the HP-IL controller may not be able to read information from the buffer fast enough to empty it before sending a command. However, if the Device Clear command is sent, the DATA SENTRY 10 will stop sending data to the interface and allow the HP-IL controller to read the data (up to 32 bytes) left in the HP-IL interface FIFO.

If the controller is not concerned with the data being sent to it by the DATA SENTRY 10, the controller can send the command without regard to the status of the FIFO. In this case, the command will be accepted by the DATA SENTRY 10, but the 32 bytes of FIFO data will be destroyed.

7.6.3 Output Control

A Data Mode command allows the user to select one of two modes:

- * SRQ ERROR
- * SRQ ALL

In the "SRQ ERROR" mode the controller should periodically address the DATA SENTRY 10 to talk. Any data that is available is sent to the controller. If no data is available, the controller will time out.

During an input sequence to the DATA SENTRY 10, if any of the faults described in Section 7.6.5 are detected, an SRQ will

Table 7-10. Status Byte Definition

Status	Byte	Condition	Definition
1 or 65	0X000001	Ready for HP-IL Data	Ready to receive data on HP-IL (HP-IL to DATA SENTRY 10).
2 or 66	0X000010	Data Ready for HP-IL	Data available in transfer buffer for HP-IL (HP-IL from DATA SENTRY 10).
4 or 68	0X000100	Buffer Full	Transfer buffer is full (HP-IL to DATA SENTRY 10).
6 or 70	0X000110	Buffer Full	Transfer buffer is full (HP-IL from DATA SENTRY 10).
8 or 72	0X001000	No Handshake	During HP-IL operation, DAVO not received within DAVO timeout period or RDYI not received.
16 or 80	0X010000	Buffer Busy	Transfer buffer not empty and data sent from external device during HP-IL to DATA SENTRY 10 operation. (Data not accepted by DATA SENTRY 10.)
32 or 96	0X100000	Manual Service Request	MSRQ line set low by DATA SENTRY 10.

The eight bits are shown in order--bit 7 (most significant) through bit 0 (least significant). An X indicates that bit 6 may be either a "0" or a "1." If bit 6 is a "1" (corresponding to the higher decimal value), the converter has originated a service request. Bit 6 is reset to a "0" when the status condition changes or a Send Status message is received.

be sent. When the controller receives the SRQ, it should immediately vector to a fault handling routine. This routine should enable the DATA SENTRY 10 to talk and receive the fault message. The controller should then analyze the fault message and perform the appropriate response.

In the "SRQ ALL" mode, an SRQ is generated whenever the DATA SENTRY 10 has new data to be sent to the controller. The controller should respond by checking the Status Byte, from which it can determine if there is any data in the interfaces FIFO. If there is no data in the HP-IL FIFO, the DATA SENTRY 10 is in HOLD mode and requires that the REL command be sent. On the occurrence of a fault condition, an SRQ will be generated and the auxiliary FIFO will be loaded with the appropriate message which will be sent out the next time the DATA SENTRY 10 is addressed to talk, regardless of the status of the HOLD function.

Results, controls and status change outputs from the HP-IL interface have the same format as described in Section 7.2. Each line of these outputs is terminated by a CR or CR LF as selected by the Data Mode TERM HP-IL command.

7.6.4 Output Sequence

A typical output sequence would consist of the following:

1. The DATA SENTRY 10 will assert SRQ, which informs the HP-IL controller that it has data to output.
2. The HP-IL controller will address the DATA SENTRY 10 to talk and check the status byte and determine if

there is any data in the HP-IL interface's FIFO. If no data is found, it will send the REL command and recheck the status.

3. The controller will accept data from the DATA SENTRY 10 until the FIFO is emptied or the controller untalks the DATA SENTRY 10.

Fault messages to the HP-IL controller have priority over the normal outputs. An example of this would be if a results print was interrupted so that the controller could change the position of a switch and a syntax fault was detected. The syntax fault would be the first output when the DATA SENTRY 10 was again addressed to talk.

7.6.5 Fault Messages

The fault messages take the form "FAULT XXX" and are terminated by a carriage return or carriage return and linefeed, as selected. The possible fault codes are:

SYN - command syntax error
OVF - command overflow error
CON - switch contention

The switch contention fault code is followed by a list of the contending switches.

7.6.6 Installation and Removal

The installation and removal instruction for the HP-IL Remote Control Option are identical to the IEEE-488 Option instructions given in Section 7.5.6.

SECTION 8

DATA INTERFACES

8.1 INTRODUCTION

Plug-in Data Interfaces are used to interface the DATA SENTRY 10 with the digital communication system under test. The Data Interface performs the electrical conversion between the TTL level signals used in the test set and the signal levels defined by the interface specification. In most cases, all data, timing, and control signals exchanged between the DATA SENTRY 10 and the system under test pass through the Data Interface.

Most Data Interfaces are designed to conform to a particular EIA, CCITT, Bell System or military standard. When performing system testing, care should be taken to select a Data Interface conforming to the same standard used by the equipment to which the DATA SENTRY 10 is to connect.

Most Data Interfaces provide separate female connectors for DTE and DCE operation, only one of which should be used at any given time. Male-to-male cables are available as options for applications where a sex change is required. For information on selection of emulation mode and the use of the Data Interface connectors, refer to Section 5.2.4.

Auxiliary functions allow the selection of the secondary (or "backwards") channel for transmission and/or reception of data on Data Interfaces conforming to standards in which secondary channels are defined. Data channels into which the

DATA SENTRY 10 is not transmitting are always held in a Marking condition. Where defined, secondary channel signaling leads are selectively activated depending upon whether the secondary channel is chosen for transmission, reception, or both. For example, with the RS-232-C/V.24 Data Interface installed and the DATA SENTRY 10 set for DTE emulation and transmission into the secondary channel, the front panel RTS switch is automatically connected to the secondary RTS line driver and the CTS indicator is automatically connected to the secondary CTS line receiver. This is done because secondary channel transmission necessitates RTS-CTS handshaking in the secondary channel. By the same token, setting the DATA SENTRY 10 to receive data from the secondary channel would result in the front panel RLSD indicator being connected to the secondary RLSD line receiver so as to maintain a correspondence between illumination of the RLSD indicator and data activity at the test set's receiver input. Secondary channel testing is covered more fully in the sections dealing with the individual Data Interfaces.

Each type of Data Interface provides self-loopback capability to allow quick verification of instrument setup and interface operation. This capability is activated by placing the DATA SENTRY 10's MODE switch in the "SELF LOOP" position and causes the outputs of the clock and primary data line drivers to be connected to the inputs of the clock and primary data line receivers, respectively. This loopback operation is performed by a relay which also disconnects the clock and primary data drivers and receivers from the panel-mounted interface connectors,

thus effectively isolating the DATA SENTRY 10 from the system under test.

Rear panel test points on the DATA SENTRY 10 provide the user with TTL level versions of the clock and data signals exchanged through the Data Interface. The test points labeled "GEN DATA" and "RCVR DATA" carry the data signals present at the output of the test set's data generator and input of the test set's digital receiver, respectively. Regardless of which Data Interface is used, a logic high at either of these test points represents a Marking condition on the associated interface line and a logic low represents a Spacing condition. On interfaces having secondary channel capability the signals at the data test points represent the data carried by the primary or secondary channel depending upon which channel is selected through Auxiliary Functions 12 and 13.

The rear panel test points labeled "GEN CLK" and "RCVR CLK" carry the timing signals used to clock data out of the test set's data generator and into the test set's receiver, respectively. Regardless of which Data Interface is used, data on the GEN DATA test point is valid on the rising edge of the clock signal present at the GEN CLK test point. For interface standards requiring data to be valid on the falling edge of the clock, the generator clock signal is inverted in the Data Interface. Most Data Interfaces contain a jumper wire which may be removed to obtain non-standard generator clock-data phasing at the interface level (i.e., a generator clock polarity opposite of that defined by the interface specification). The status of this jumper does not affect generator clock-data phasing at the GEN CLK and GEN DATA test points.

For proper operation of the DATA SENTRY 10's receiver, data present on the RCVR DATA test point must be valid on the rising edge of the clock signal at the RCVR CLK test point. If the equipment to which the DATA SENTRY 10 is connected complies with the same interface standard as the installed Data Interface, this will always be the case. If the system under test is sending the DATA SENTRY 10 a clock that is inverted with respect to the interface standard, the signal at the RCVR DATA test point will appear valid on the falling edge of the clock signal at the RCVR CLK test point and improper receiver operation may result.

Most Data Interfaces contain a jumper wire which may be removed to allow the test set to operate with an inverted received clock. The effect of removing this jumper is to invert the incoming clock immediately after the Data Interface so that the received data will be valid on the rising edge of the clock at the input of the digital receiver. This clock polarity change will be reflected in the relative clock-data phasing at the RCVR CLK and RCVR DATA test points.

CAUTION

Instrument power must be OFF when removing or installing Data Interfaces. Removing or installing Data Interfaces with the power ON may result in equipment damage not covered by warranty.

8.2 RS-232-C/V.24 DATA INTERFACE

8.2.1 General

This Data Interface meets the requirements of EIA Standard RS-232-C and CCITT Recommendations V.24 and V.28. Two 25-pin female D-subminiature connectors are used to interface to the DATA SENTRY 10.

The clock and data line drivers employed in this interface produce bipolar unbalanced output signals that are slew-rate limited to approximately $25 \text{ V}/\mu\text{s}$ in keeping with the interface standards. Since signaling lines are allowed to transition more slowly, the outputs of all signaling drivers are slew-rate limited to about $2 \text{ V}/\mu\text{s}$ to reduce the possibility of any crosstalk resulting from signaling changes. All line receivers used in this Data Interface exhibit approximately 1 volt of input hysteresis and in addition employ noise filtering circuitry. These features greatly reduce the receivers' sensitivity to line noise resulting from crosstalk and external sources.

8.2.2 Functional Description

8.2.2.1 Emulate DTE Operation

Figure 8-1 is a block diagram of the RS-232-C/V.24 Data Interface. When the DATA SENTRY 10 is emulating a DTE, the system under test should be connected to the Data Interface connector labeled "TO DCE" and nothing should be attached to the connector marked "TO DTE." Interface connector pin assignment information is provided in Table 8-1 (Section 8.2.4).

For transmission in the primary channel, the DATA SENTRY 10's generator data and clock outputs drive line drivers number 3 and 4 which in turn provide interface level data and clock signals to the DTE connector's transmitted data and transmit signal element timing (DTE source) lines. The output of line receiver number 7 provides transmit signal element timing (DCE source) for use as the generator clock when the DATA SENTRY 10's GEN CLK switch is set to the "INTF" position. The secondary generator data line from the test set is held in the marking condition when transmitting in the primary channel.

For transmission in the secondary channel, the DATA SENTRY 10 provides generator data to line driver number 1 which drives the secondary transmitted data line of the emulate DTE connector. No clock signal is involved when transmitting into the secondary channel, and the primary generator data output is held marking.

When receiving from the primary channel, line receiver number 5 provides data to the input of the test set's digital receiver from the interface's received data line. Line receiver number 6 provides the DATA SENTRY 10 with a receiver clock from the DTE connector's receiver signal element timing (DCE source) input.

When receiving from the secondary channel, the DATA SENTRY 10 selects its receiver data from line receiver number 2 which provides secondary received data from the interface. No clocks are used for secondary channel reception.

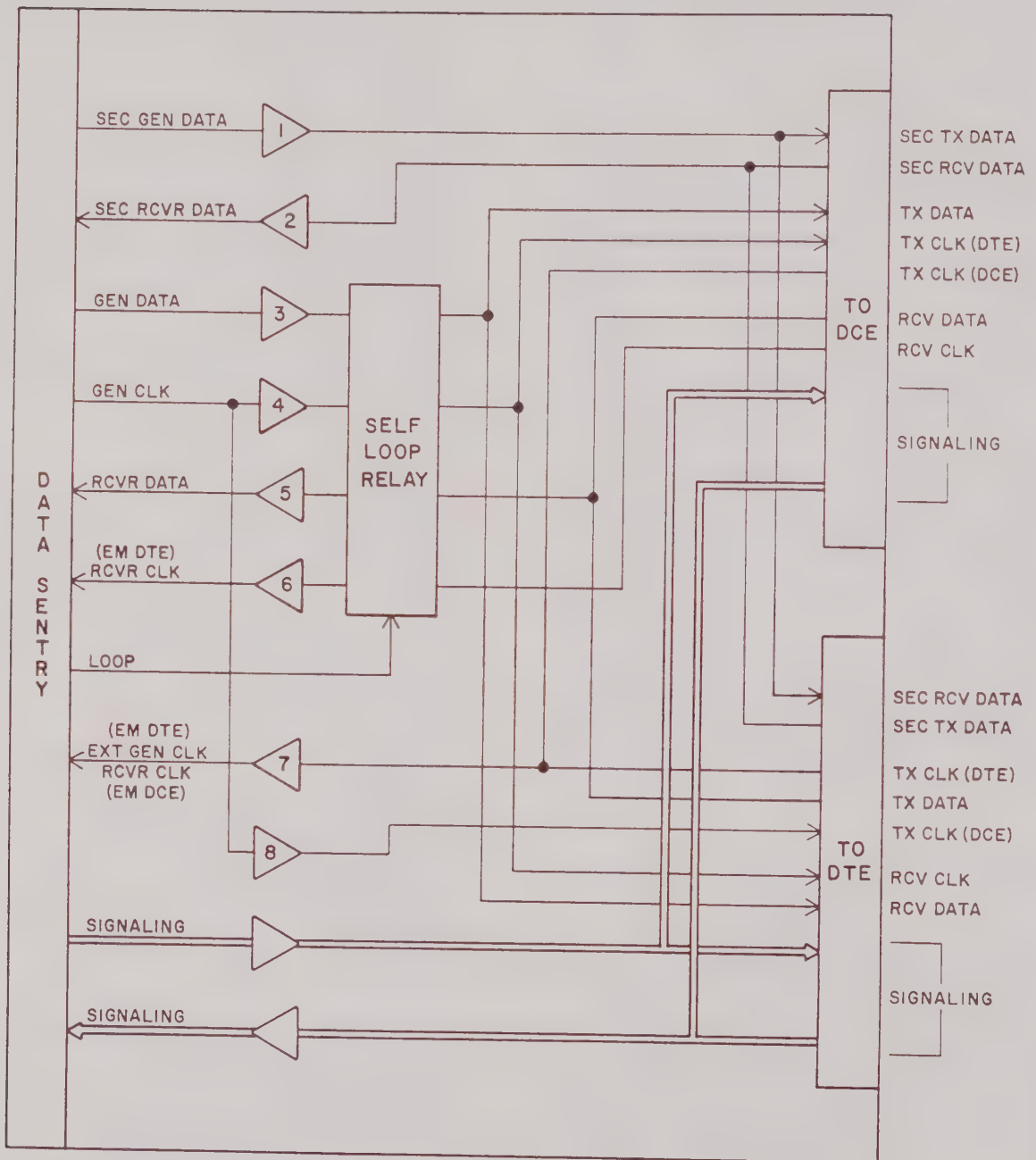


Figure 8-1
BLOCK DIAGRAM, RS-232-C/V.24 DATA INTERFACE

Table 8-1

RS-232-C/V.24 Data Interface Connector Pin Assignments

PIN	CIRCUIT		SIGNAL NAME	LEAD STATUS ON DATA INTERFACE	
	EIA	CCITT		EMULATE DTE ("TO DCE")	EMULATE DCE ("TO DTE")
1	AA	101	Protective Ground	Internally connected to chassis ground	
2	BA	103	Transmitted Data		
3	BB	104	Received Data	output	input
4	CA	105	Request to Send	input	output
5	CB	106	Clear to Send	output	input
6	CC	107	Data Set Ready	input	output
7	AB	102	Signal Ground (Common Return)	Internally connected to signal ground	
8	CF	109	Received Line Signal Detector		
9	--	--	(Reserved for Data Set Testing)	input	output
10	--	--	(Reserved for Data Set Testing)	open	open
11			Unassigned	open	open
12	SCF	122	Secondary Received Line Signal Detector	open	open
13	SCB	121	Secondary Clear to Send	input	output
14	SBA	118	Secondary Transmitted Data	output	input
15	DB	114	Transmit Signal Element Timing (DCE Source)	input	output
16	SBB	119	Secondary Received Data	input	output
17	DD	115	Receiver Signal Element Timing (DCE Source)	input	output
18	--	--	Unassigned	open	open
19	SCA	120	Secondary Request to Send	output	input
20	CD	108/2	Data Terminal Ready	output	input
21	CG	110	Signal Quality Detector	open	open
22	CE	125	Ring Indicator	input	open
23	CH	111	Data Signal Rate Selector (DTE Source)	output	input
24	DA	113	Transmit Signal Element Timing (DTE Source)	output	input
25	--	--	Unassigned	open	open

In Emulate DTE mode, the DATA SENTRY 10 always provides signaling outputs that drive the DTR and SR lines and always monitors the state of the DSR and RI lines (controlled by the DCE). Since these four lines do not have any secondary channel counterparts they are unaffected by transmit and receive channel selection. Additional signaling leads supported by the test set are dependent upon the selection of primary or secondary channel operation.

When Auxiliary Function 12 is used to select the primary channel for transmitted data all data originating at the DTE (the test set in Emulate DTE mode) is routed through the (primary) transmitted data interface line. In keeping with this channel selection the DATA SENTRY 10 drives the (primary) RTS line and monitors the (primary) CTS line. When the secondary channel is selected for transmitted data, the test set drives the secondary RTS line and monitors the secondary CTS line.

When Auxiliary Function 13 is used to select the primary channel for received data (data originating at the DCE), the DATA SENTRY 10's RLSD indicator always reflects the state of the (primary) RLSD signaling lead. It does so because the primary RLSD line is used by the DCE to notify the DTE when data is present on the primary received data line. For a similar reason, when the secondary channel is selected for received data the RLSD indicators always reflects the state of the secondary RLSD signaling lead. The RLSD LOST indicator always applies to whichever RLSD lead is being monitored by the test set.

8.2.2.2. Emulate DCE Operation

When the DATA SENTRY 10 is emulating a DCE, the system under test should be connected to the Data Interface connector labeled "TO DTE" and nothing should be attached to the connector marked "TO DCE." In DCE emulation the test set outputs its clock and data signals into what is referred to by the interface standards as the receive channel. Signals in the receive channel always flow from the DCE to the DTE. By the same token signals in the transmit channel always flow from the DTE to the DCE. Knowledge of these definitions is requisite to the understanding of the following discussion of DCE emulation with the DATA SENTRY 10.

When Auxiliary Function 13 is used to select the primary receive channel, the DATA SENTRY 10's generator data and clock outputs drive line drivers number 3 and 4 which in turn drive the DCE connector's received data and receiver signal element timing (DCE source) lines. The test set's generator clock output also drives line driver number 8 to provide transmit signal element timing (DCE source) to the DTE. The output of line receiver number 7 provides transmit signal element timing (DTE source) for use as the test set's generator clock when the front panel GEN CLK switch is set to the "INTF" position. The secondary generator data line from the test set is held marking in DCE emulation when the primary receive channel has been selected.

When the secondary receive channel has been selected, the DATA SENTRY 10 provides generator data to line driver number 1 which drives the secondary received data line on the DCE emulation connector. No clock signal accompanies this data. The test set's primary

generator data output is held marking when the instrument is outputting data into the secondary receive channel.

For reception from the primary transmit channel in Emulate DCE mode, line receiver number 5 provides the DATA SENTRY 10 with data sent by the DTE over the transmitted data line and line receiver number 7 provides a clock to the test set's digital receiver derived from the transmit signal element timing (DTE source) line. Depending upon the setting of the receiver clock select auxiliary function (access code 22) and the presence or absence of a signal on the transmit signal element timing (DTE source) line the test set may also internally select its own generator clock output for use as the receiver clock.

For reception from the secondary transmit channel, the DATA SENTRY 10 selects its receiver data from line receiver number 2 which is driven by the secondary transmitted data line. Since no clock accompanies the data on the secondary transmitted data line, no clock is received (implying use of the Recovered or Asynchronous timing modes).

In Emulate DCE mode the DATA SENTRY 10 always provides a signaling output that drives the DSR line and always monitors the DTR and SR lines. Since these lines have no secondary channel counterparts they are unaffected by transmit and receive channel selection. Additional signaling leads supported by the test set in DCE emulation are dependent upon the selection of primary or secondary channel operation.

When Auxiliary Function 12 is used to select the primary transmit channel the DATA SENTRY 10 drives the (primary)

CTS line and the front panel RTS indicator reflects the state of the (primary) RTS line. When the secondary transmit channel is selected the test set drives the secondary CTS line and monitors the secondary RTS line.

Using Auxiliary Function 13 to select the primary receive channel results in the (primary) RLSD line being driven by the test set. The secondary RLSD line is driven instead whenever the secondary receive channel is selected.

8.2.3 Clock-Data Phasing

According to EIA standard RS-232-C and CCITT Recommendation V.24, all data exchanged between the DTE and the DCE must be valid at the falling edge of the accompanying clock (i.e., data transitions should occur upon rising edges of the clock). In keeping with this, all data transmitted by the DATA SENTRY 10 is valid each time the interface line driven by the test set's generator clock signal transitions from a high state (greater than +3 volts) to a low state (less than -3 volts). This interface-level clock signal may be inverted by removing the jumper wire labeled "JW1" from the Data Interface's PC board. This will result in the data generated by the test set changing to rising edge valid with respect to the accompanying interface clock. Note that when this jumper is removed the Data Interface no longer conforms to the interface standards.

Whenever the DATA SENTRY 10 is set up to receive data accompanied by a clock it expects the incoming data to be valid on the falling edge of its associated interface clock. For special cases, the test set may be configured to accommodate data that is rising edge valid with

respect to its associated clock. This may be done by removing the jumper wire labeled "JW2" from the Data Interface's PC board. When this has been done the Data Interface no longer conforms to RS-232-C and V.24.

8.2.4 Specifications

General:

Maximum Data Rate - 20 kbps*

Data and Signaling Polarity -

Data Mark (binary "1")/control lead OFF: < -3 volts

Data Space (binary "0")/control lead ON: >+3 volts

Drivers:

Output Levels into 3k ohm Load (typical)-

Low Level: -10 volts $\pm$ 1 volt

High Level: +10 volts $\pm$ 1 volt

Slew Rates into 7k ohm Resistive Load (typical)-

Clock and Data: 25 volts/ μ s

Signaling: 2 volts/ μ s

Maximum Short-Circuit Current: $\pm$ 12 mA

Receivers:

Input Impedance - 3k to 7k ohms

Input Threshold (typical) -

Positive - going: +2 volts

Negative - going: +1 volt

Maximum Input Voltage: $\pm$ 25 volts

* This is the speed limitation set forth in RS-232-C and V.28. This Data Interface may typically be used at speeds up to about 100 kbps (depending upon the system under test) at the cost of increased bias distortion at the line receiver outputs and increased receiver clock-data skew.

8.3 V.35/306 DATA INTERFACE

8.3.1 General

This Data Interface is designed to meet the requirements of CCITT Recommendation V.35, ISO Standard 2593, and Bell System Technical Reference PUB 41304 (306-Type Interface Specification). Two 34-pin female connectors are used to interface to the DATA SENTRY 10.

Data and clock interface circuits use bipolar balanced line drivers and receivers as described in Appendix II of CCITT Recommendation V.35 and in Bell System PUB 41304. Signaling interface circuits use bipolar unbalanced line drivers and receivers meeting EIA RS-232-C and CCITT V.28 recommendations. Both balanced and unbalanced line receivers employ hysteresis and noise filtering to reduce the receivers' sensitivity to noise and crosstalk.

8.3.2 Functional Description

8.3.2.1 Emulate DTE Operation

Figure 8-2 is a block diagram of the V.35/306 Data Interface. When the DATA SENTRY 10 is emulating a DTE, the equipment under test should be connected to the Data Interface connector labeled "TO DCE", and nothing should be connected to the connector marked "TO DTE." Interface connector pin assignment information is provided in Table 8-2 (Section 8.3.4).

The DATA SENTRY 10's generator data and clock outputs drive line drivers

number 1 and 2, which in turn provide bipolar balanced data and clock signals to the Send Data (SD) and Serial Clock Transmit External (SCTE) lines. The output of line receiver number 5 provides Serial Clock Transmit (SCT) for use as the generator clock when the DATA SENTRY 10's GEN CLK switch is set to "INTF".

Line receiver number 3 provides data to the input of the test set's receiver from the Receive Data (RD) line. Line receiver number 4 provides the DATA SENTRY 10 with a receiver clock from the DTE connector's Serial Clock Receive (SCR) line.

In the Emulate DTE mode, the DATA SENTRY 10 provides bipolar unbalanced outputs for Request to Send (RTS) and Data Terminal Ready (DTR). Bipolar unbalanced line receivers are provided for Clear to Send (CTS), Data Set Ready (DSR), Received Line Signal Detect (RLSD), and Ring Indicator (RI). The driver outputs are controlled by DATA SENTRY 10 front panel switches, and the line receiver inputs are monitored by front panel LEDs.

8.3.2.2 Emulate DCE Operation

When the DATA SENTRY 10 is emulating a DCE, the equipment under test should be attached to the connector labeled "TO DTE", and nothing should be connected to the connector marked "TO DCE." In DCE emulation, the test set outputs its clock and data signals into what is referred to by the interface standards as the receive channel. Signals in the receive channel always flow from the DCE towards the DTE. Similarly, signals in transmit channel always flow from the DTE towards the DCE.

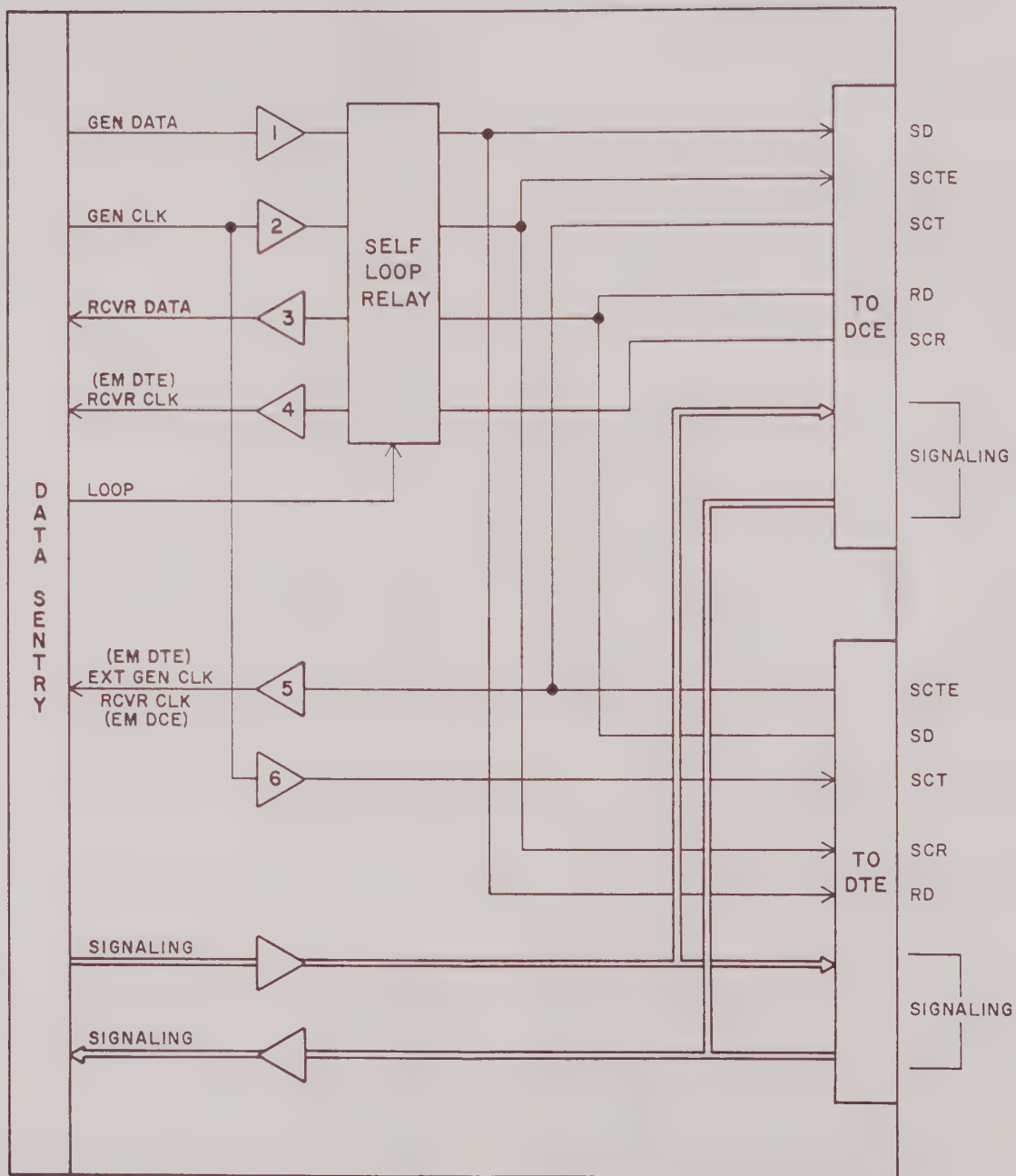


Figure 8-2
BLOCK DIAGRAM, V.35/306 DATA INTERFACE

The DATA SENTRY 10's generator data and clock outputs drive line drivers number 1 and 2, which in turn provide bipolar balanced data and clock signals to the Receive Data (RD) and Serial Clock Receive (SCR) lines. The test set's generator clock also drives line driver number 6 to provide Serial Clock Transmit (SCT) to the DTE. The output of line receiver number 5 provides Serial Clock Transmit External (SCTE) for use as the test set's generator clock when the front panel GEN CLK switch is set to "INTF."

Line receiver number 3 provides the DATA SENTRY 10 with data sent by the DTE over the Send Data (SD) line, and line receiver number 5 provides a clock to the test set's receiver derived from Serial Clock Transmit External (SCTE). Depending on the setting of the receiver clock select auxiliary function (access code 22) and the presence or absence of a signal on SCTE, the test set may internally select its own generator clock for use as the receiver clock.

In the Emulate DCE mode, the DATA SENTRY 10 provides bipolar unbalanced outputs for Clear to Send (CTS), Data Set Ready (DSR), and Received Line Signal Detect (RLSD). Bipolar unbalanced line receivers are provided for Request to Send (RTS) and Data Terminal Ready (DTR). The driver outputs are controlled by front panel switches, and the line receiver inputs are monitored by front panel LEDs.

When emulating a DTE, the Data Interface may be configured to receive and display (via the RI LED) the Bell System Local Test (LT) signal. If this is desired, a jumper wire must be installed in the "JW3" position on the Data Interface's PC board.

8.3.3 Clock-Data Phasing

According to the Bell System's 306 Interface Specification and conventional implementation of CCITT Recommendation V.35, all data exchanged between the DTE and the DCE must be valid on the ON-to-OFF transition of the accompanying clock (i.e., data transitions should occur on the OFF-to-ON transition of the clock). All data transmitted by the DATA SENTRY 10 (on either SD or RD) is valid on the ON-to-OFF transition of the accompanying clock (either SCTE or SCR).

If the opposite clock-data phasing is required (data valid on the OFF-to-ON clock transition), the generated clock signal may be inverted by removing the wire labeled "JW1" from the Data Interface's PC board. Note that when this jumper is removed the Data Interface no longer conforms to the interface standards.

The DATA SENTRY 10 also expects the incoming data to be valid on the ON-to-OFF transition of the accompanying clock. If the Data Interface must operate with the opposite clock-data phasing, the received clock may be inverted by removing the wire labeled "JW2" from the Data Interface's PC board. Note that when this jumper is removed the interface standards are violated.

8.3.4 Specifications

General:

Maximum Data Rate - 500 kbps

Data Polarity -

Mark (binary "1"): "A" lead negative with respect to "B" lead

Space (binary "0"): "A" lead positive with respect to "B" lead

Clock Polarity -

OFF: "A" lead negative with respect to "B" lead

ON: "A" lead positive with respect to "B" lead

Signaling Polarity -

OFF: less than -3 volts

ON: greater than +3 volts

Data and Clock Drivers:

Source Impedance - 100 ± 50 ohms

Resistance from Short-Circuited Terminals to Ground - 150 ± 15 ohms

Output Level ("A" minus "B", 100 ohm load) - 0.55 volts $\pm 20\%$

Rise Time (10% to 90% levels, 100 ohm load) - 15 ns typical, 40 ns maximum

DC Line Offset (100 ohm load) - 0.0 volt typical, 0.6 volt maximum

Data and Clock Receivers:

Input Impedance - 100 ± 10 ohms

Resistance from Short-Circuited Terminals to Ground - 150 ± 15 ohms

Input Hysteresis - 70 mv typical

Signaling Drivers:

Output Levels into 3k ohm load (typical) -

OFF: -10 volts ± 1 volt

ON: +10 volts ± 1 volt

Slew Rate into 7k ohm load (typical) - 2 volts/ μ s

Maximum Short-Circuited Current - ± 12 mA

Signaling Receivers:

Input Impedance - 3k to 7k ohms

Input Thresholds (typical) -

OFF to ON: +2 volts

ON to OFF: +1 volt

Maximum Input Voltage - ± 25 volts

Table 8-2. V.35/306 Data Interface Connector Pin Assignments

PIN	CIRCUIT		SIGNAL NAME	LEAD STATUS ON DATA INTERFACE	
	EIA	CCITT		EMULATE DTE ("TO DCE")	EMULATE DCE ("TO DTE")
A	AA	101	Protective Ground	Internally connected to chassis ground	
B	AB	102	Signal Ground (Common (Return)		
C	CA	105	Request to Send	output	input
D	CB	106	Clear to Send/Ready for Sending	input	output
E	CC	107	Data Set Ready	input	output
F	CF	109	Received Line Signal Detector	input	output
H	CD	108/2	Data Terminal Ready	output	input
J	CE	125	Ring Indicator/Calling Indicator	input	--
K	--	--	Local Test (see text)	--	(see text)
P,S	--	103	Send Data (SD)/Transmitted Data	output	input
R,T	--	104	Receive Data (RD)	input	output
U,W	--	113	Serial Clock Transmit External (SCTE)/Transmit Signal Element Timing (DTE Source)	output	input
V,X	--	115	Serial Clock Receive (SCR)/ Receiver Signal Element Timing	input	output
Y,AA	--	114	Serial Clock Transmit (SCT)/Signal Element Timing (DCE Source)	input	output

Note: For balanced circuits the "A" lead is listed first, the "B" lead second.

8.4 RS-449/MIL-188-114/MIL-188C DATA INTERFACE

8.4.1 General

This Data Interface meets the electrical requirements of EIA standard RS-449 for both balanced (RS-422-A) and unbalanced (RS-423-A) operation of Category I circuits. Additionally, it meets the requirements of FED-STD-1020, FED-STD-1030, MIL-STD-188-114 (balanced and unbalanced), and is compatible with equipment conforming to the old version of MIL-STD-188C dated 24 November 1969. Separate 37-pin female D-subminiature connectors are provided for primary channel communication in each emulation mode, and each of these connectors is paired with a 9-pin female D-subminiature connector for secondary channel communication. The pin-outs and mechanical characteristics of these connectors conform to RS-449.

All ten Category I circuits defined by RS-449 are implemented on this Data Interface. They are:

- SD (Send Data)
- RD (Receive Data)
- TT (Terminal Timing)
- ST (Send Timing)
- RT (Receive Timing)
- RS (Request To Send)
- CS (Clear To Send)
- RR (Receiver Ready)
- TR (Terminal Ready)
- DM (Data Mode)

Depending upon the setting of the interface's MODE switch these lines are either driven by bipolar balanced drivers meeting RS-422-A, MIL-STD-188-114 (balanced) and FED-STD-1020, or by bi-

polar unbalanced drivers meeting RS-423-A, MIL-STD-188-114 (unbalanced), FED-STD-1030, and old MIL-STD-188C.

The following Category II circuits are implemented:

- IC (Incoming Call)
- SR (Signaling Rate Selector)
- IS (Terminal In Service)
- TM (Test Mode)
- SSD (Secondary Send Data)
- SRS (Secondary Request To Send)
- SCS (Secondary Clear To Send)
- SRR (Secondary Receiver Ready)

Where category II circuits are driven by the Data Interface, bipolar unbalanced drivers are always used.

8.4.2 Modes of Operation

Four basic modes of operation are provided by the RS-449/MIL-188-114/MIL-188C Data Interface. In the RS-422 Unterminated mode, all Category I circuits are driven by balanced drivers and all receivers are differential and have high impedance inputs (>4k ohms, including failsafe networks). Selection of the RS-422 Terminated mode causes 130 ohm terminating resistors to be connected across the inputs of the clock and data receivers providing a better impedance match to the line. These terminations significantly reduce the effects of cross-talk, line reflections, and EMI that could cause erroneous receiver outputs. In both RS-422 modes the interface also meets the electrical requirements of MIL-STD-188-114 for balanced operation.

In the RS-423 and MIL-188C modes of operation, all outgoing lines are driven by

unbalanced drivers that also meet the requirements of MIL-STD-188-114 for unbalanced operation. The "B" leads of all outgoing category I circuits are tied to signal ground inside the Data Interface in these modes. All receivers have high impedance differential inputs and thus one input of each receiver must be grounded through the interface cable for proper unbalanced operation. For Category I circuits the "B" leads of each receiver should be grounded and for Category II circuits either the Send Common or Receive Common line should be grounded through the interface cable depending upon emulation mode.

The only difference between MIL-188C mode and RS-423 mode operation of the interface is the data polarity sense. A "Mark" is defined as a positive voltage (with respect to ground) by the old version of MIL-STD-188C and as a negative voltage by RS-423-A. Thus in MIL-188C operation data signals originating at the DATA SENTRY 10 are inverted with respect to RS-423 mode operation and the test set's receiver is conditioned to look for data that is inverted with respect to the RS-423-A definition. Note that the front panel "MK" and "SP" indicators and the state indication in the bias distortion measurement always indicate data polarity according to RS-423-A definition when the Data Interface is operating in an unbalanced mode, meaning that these Mark and Space indications pertaining to incoming data are reversed in MIL 188C mode.

The interface connector pin assignments defined by RS-449 are used for all four operating modes of the Data Interface. To accommodate equipment employing a 25-pin D-subminiature connector with pinouts defined by EIA Standard RS-232, a 37-pin D to 25-pin D male-to-male adaptor cable (Model 10496) is available.

A schematic diagram of this cable is shown in Figure 8-4 (Section 8.4.5). Note that connection of the cable to the Data Interface automatically grounds the appropriate input lead to each differential receiver allowing proper unbalanced operation without the need for external ground connections.

Operating mode selection for the RS-449/MIL-188-114/MIL-188C Data Interface may be accomplished in either of two ways. A 4-position electronic switch on the interface's panel provides the most straightforward method of mode selection. This switch operates in the same manner as most of the DATA SENTRY 10's front panel switches. In addition, an auxiliary function allows the mode of the Data Interface to be controlled and monitored from the test set's front panel as well as through a remote controller. The access code of the auxiliary function is 85 and the status choice abbreviations are "188C", "423", "422U", and "422T" corresponding respectively to the MIL-188C, RS-423, RS-422 Unterminated, and RS-422 Terminated modes of operation. This auxiliary function is identical in operation to the status select functions described in section 4.6.2 with the exception of the fact that the setting of this function does not affect the front panel "AUX FUNC IN USE" indicator as there is no "normal" setting. The auxiliary function abbreviation "449" will appear at the left side of the test set's left-hand alphanumeric display when the function has been properly accessed. Access of Auxiliary Function 85 precludes interface mode control through the electronic switch on the Data Interface itself for the duration of the access. The switch position indicator LEDs on the interface panel always reflect the current mode of operation.

8.4.3 Functional Description

8.4.3.1 Emulate DTE Operation

Figure 8-3 is a block diagram of the RS-449/MIL-188-114/MIL-188C Data Interface. When the DATA SENTRY 10 is emulating a DTE, the system under test should be connected to the Data Interface connector(s) labeled "TO DCE" and nothing should be attached to the connectors marked "TO DTE." For primary channel testing only the 37-pin D connector need be attached to the equipment under test, whereas for secondary channel testing only the 9-pin connector need be used. If desired both connectors may be simultaneously attached to the system under test. Interface connector pin assignment information is provided in Tables 8-3 and 8-4 (Section 8.4.5).

For transmission in the primary channel, the DATA SENTRY 10's generator data and clock outputs drive line drivers number 3 and 4 which in turn provide interface level data and clock signals to the 37-pin DTE connector's Send Data (SD) and Terminal Timing (TT) lines, respectively. The output of line receiver number 7 provides Send Timing (ST) for use as the generator clock when the DATA SENTRY 10's GEN CLK switch is set to the "INTF" position. The secondary generator data line from the test set is held in the Marking condition when transmitting in the primary channel.

For transmission in the secondary channel, the DATA SENTRY 10 provides generator data to line driver number 1 which drives the Secondary Send Data (SSD) line of the 9-pin emulate DTE connector. No clock signal is involved

when transmitting into the secondary channel, and the primary generator data output is held Marking.

When receiving from the primary channel, line receiver number 5 provides data to the input of the test set's digital receiver from the interface's Receive Data (RD) line. Line receiver number 6 provides the DATA SENTRY 10 with a receiver clock from the 37-pin DTE connector's Receive Timing (RT) input.

When receiving from the secondary channel, the DATA SENTRY 10 selects its receiver data from line receiver number 2 which provides Secondary Receive Data (SRD) from the interface. No clocks are used for secondary channel reception.

In Emulate DTE mode, the DATA SENTRY 10 always provides signaling outputs that drive the Terminal Ready (TR) and Signaling Rate (SR) lines, controlled by the front panel DTR and SR switches, respectively. The ON or OFF conditions of the DSR and RI indicator LEDs reflect the corresponding states of the Data Mode (DM) and Incoming Call (IC) interface signals (controlled by the DCE). Since TR, SR, DM, and IC do not have any secondary channel counterparts they are unaffected by transmit and receive channel selection. Additional signaling leads supported by the test set are dependent upon the selection of primary or secondary channel operation. When Auxiliary Function 12 is used to select the primary transmit channel all data originating at the DTE is routed through the primary Send Data interface line. In keeping with this channel selection the DATA SENTRY 10's RTS switch controls the state of the primary Request To Send (RS) line and its CTS indicator monitors the state of the

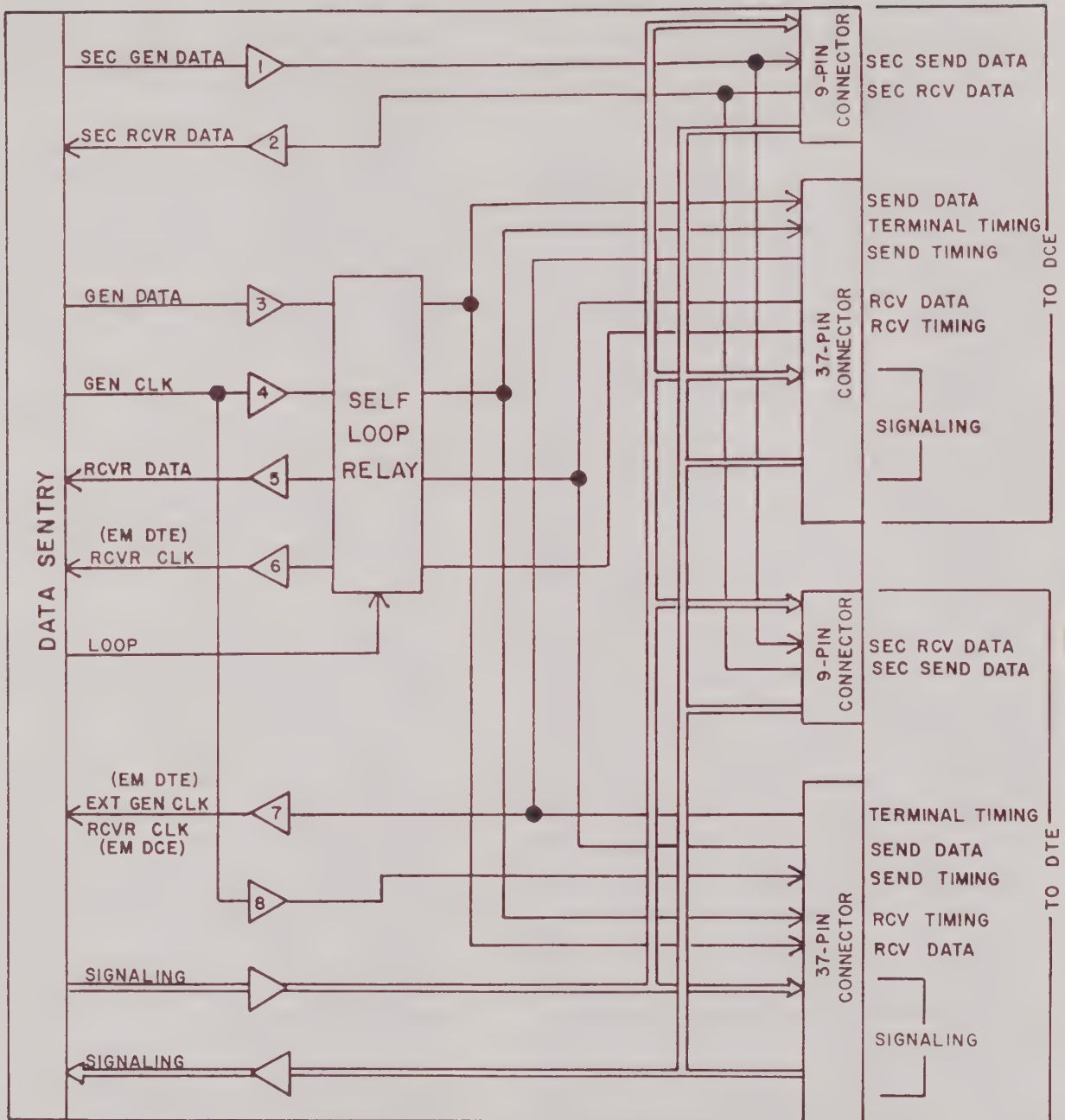


Figure 8-3

BLOCK DIAGRAM, RS-449/MIL 188-114/MIL 188C DATA INTERFACE

primary Clear To Send (CS) line. When the secondary transmit channel is selected, the test set's RTS switch controls the Secondary Request To Send (SRS) line and its CTS indicator reflects the state of the Secondary Clear To Send (SCS) line.

When Auxiliary Function 13 is used to select the primary channel for received data (data originating at the DCE), the DATA SENTRY 10's RLSD indicator always reflects the state of the primary Receiver Ready (RR) signaling lead. It does so because the primary RR line is used by the DCE to notify the DTE when data is present on the primary received data line. For a similar reason, when the secondary channel is selected for received data the RLSD indicator always reflects the state of the Secondary Receiver Ready (SRR) signaling lead. The RLSD LOST indicator always applies to whichever RR lead is being monitored by the test set.

In DTE emulation the DATA SENTRY 10 always drives the Terminal In Service (IS) line. It is OFF whenever the test set is in SELF LOOP Mode (indicating that the test set is not "on line") and ON at all other times.

8.4.3.2 Emulate DCE Operation

When the DATA SENTRY 10 is emulating a DCE, the system under test should be connected to the Data Interface connector(s) labeled "TO DTE" and nothing should be attached to the connectors marked "TO DCE." In DCE emulation the test set outputs its clock and data signals into what is referred to by the interface standards as the receive channel. Signals in the receive channel always flow from the DCE to the DTE.

By the same token signals in the transmit channel always flow from the DTE to the DCE. Knowledge of these definitions is requisite to the understanding of the following discussion of DCE emulation using the RS-449/MIL-188-114/MIL-188C Data Interface.

When Auxiliary Function 13 is used to select the primary receive channel, the DATA SENTRY 10's generator data and clock outputs drive line drivers number 3 and 4 which in turn drive the 37-pin DCE connector's Receive Data (RD) and Receive Timing (RT) lines. The test set's generator clock output also drives line driver number 8 to provide Send Timing (ST) to the DTE. The output of line receiver number 7 provides Terminal Timing (TT) for use as the test set's generator clock when the front panel GEN CLK switch is set to the "INTF" position. The secondary generator data line from the test set is held Marking in DCE emulation when the primary receive channel has been selected.

When the secondary receive channel has been selected, the DATA SENTRY 10 provides generator data to line driver number 1 which drives the Secondary Receive Data (SRD) line on the 9-pin DCE emulation connector. No clock signal accompanies this data. The test set's primary generator data output is held Marking when the instrument is outputting data into the secondary receive channel.

For reception from the primary transmit channel in Emulate DCE mode, line receiver number 5 provides the DATA SENTRY 10 with data sent by the DTE over the Send Data (SD) line and line receiver number 7 provides a clock to the test set's digital receiver derived from the Terminal Timing (TT) line.

Depending upon the setting of the receiver clock select auxiliary function (access code 22) and the presence or absence of a signal on the Terminal Timing line the test set may also internally select its own generator clock output for use as the receiver clock.

For reception from the secondary transmit channel, the DATA SENTRY 10 selects its receiver data from line receiver number 2 which is driven by the Secondary Send Data (SSD) line. Since no clock accompanies the data on the Secondary Send Data line, no clock is received (implying use of the Recovered or Asynchronous Timing modes).

In Emulate DCE mode the DATA SENTRY 10's DSR switch always controls the state of the Data Mode (DM) line and its DTR indicator always monitors the state of the Terminal Ready (TR) line. Since these lines have no secondary channel counterparts they are unaffected by transmit and receive channel selection. Additional signaling leads supported by the test set in DCE emulation are dependent upon the selection of primary or secondary channel operation. When Auxiliary Function 12 is used to select the primary transmit channel the DATA SENTRY 10's CTS switch controls the state of the primary Clear To Send (CS) line and the RTS indicator reflects the state of the primary Request To Send (RS) line. When the secondary transmit channel is selected, the CTS switch controls the Secondary Clear To Send (SCS) line and the RTS indicator monitors the Secondary Request To Send (SRS) line.

Using Auxiliary Function 13 to select the primary receive channel results in the primary Receiver Ready (RR) line being controlled by the test set's RLSD switch.

The Secondary Receiver Ready (SRR) line is controlled instead whenever the secondary receive channel is selected.

In DCE emulation the test set always drives the Test Mode (TM) line. This line is driven ON whenever the test set is in SELF LOOP mode indicating that the test set is in a local test mode and is not available for service. In all other operating modes this line is held in the OFF state.

8.4.4 Clock-Data Phasing

According to EIA standard RS-449, MIL-STD-188-114, and MIL-STD-188C, all data exchanged synchronously between a DTE and a DCE must be valid at the ON-to-OFF transition of the accompanying clock signal (i.e., data transitions should occur upon OFF-to-ON transitions of the clock). All data transmitted by the DATA SENTRY 10 (on either SD or RD) is valid on the ON-to-OFF transition of the accompanying clock (either TT or RT). If the opposite clock-data phasing is required (data valid on the OFF-to-ON clock transition), the generated clock signal may be inverted by removing the jumper wire labeled "JW2" from the Data Interface's main PC board. Note that when this jumper is removed the Data Interface no longer conforms to the interface standards. In DTE emulation, phase correspondence between TT and ST is always maintained regardless of jumper status.

For synchronous reception, the DATA SENTRY 10 expects incoming data to be valid on the ON-to-OFF transition of the accompanying clock. If the Data Interface must operate with the opposite clock-data phasing, the received clock

may be inverted by removing the jumper wire labeled "JW3" from the Data Interface's main PC board. When this is done the Data Interface no longer conforms to the interface standards.

8.4.5 Specifications

General:

Maximum Data Rate: MIL-188C - 65 kbps
RS-423 - 130 kbps
RS-422 - (Terminated and Unterminated) - 500 kbps

Data Polarity:

MIL-188C -

Mark (binary "1"): "A" lead positive with respect to signal ground
Space (binary "0"): "A" lead negative with respect to signal ground

RS-423 -

Mark (binary "1"): "A" lead negative with respect to signal ground
Space (binary "0"): "A" lead positive with respect to signal ground

RS-422 -

Mark (binary "1"): "A" lead negative with respect to "B" lead
Space (binary "0"): "A" lead positive with respect to "B" lead

Clock and Signaling Polarity:

MIL-188C, RS-423 -

OFF: "A" lead negative with respect to signal ground
ON: "A" lead positive with respect to signal ground

RS-422 -

OFF: "A" lead negative with respect to "B" lead
ON: "A" lead positive with respect to "B" lead

Unbalanced Drivers:

Output Level (magnitude, both states) -
into open circuit (V_O): 5.5 ± 0.5 volts
into 3K ohm load: 5.5 ± 0.5 volts
into 450 ohm load: $0.9\bar{V}_O$

Source Impedance - 25 ohms typical, 50 ohms maximum

Output Short-Circuit Current (Magnitude, both states) - 40 mA typical, 150 mA maximum

Output Leakage, Power Off, for applied voltages in -6V to +6V range: $\pm 100\mu\text{A}$ maximum

Output Rise Time (10% to 90% levels) -

clock drivers: $1.2\mu\text{s}$ maximum

data drivers: $2.3\mu\text{s}$ maximum

signaling drivers: $10\mu\text{s}$ typical

Balanced Drivers

Output Level [magnitude of (A-B), both states] -

into open circuit (V_O): 4.6 volts typical, 5.0 volts maximum

into 100 ohm load: MAX (2.0 volts, $0.5V_O$)

Output Level Imbalance Between Output States (100 ohm load): ± 0.2 volts

Output Offset (or common mode) Voltage With Respect to Signal Ground -

into open circuit: ± 0.2 volts typical, ± 0.4 volts maximum

into 100 ohm load: 0.0 volts typical, ± 0.4 volts maximum

Output Offset Voltage Imbalance Between Output States

(100 ohm load): ± 0.2 volts maximum

Output Short Circuit Current, Each Output, With Both Outputs Connected To Ground: ± 150 mA maximum

Output Leakage, Power Off, For Applied Voltages in -6V to +6V range at each output: ± 100 mA maximum

Output Rise Time (10% to 90% levels, 100 ohm load) - 60 ns typical, 100 ns maximum

Receivers (specified with Failsafe networks):

Input Impedance -

differential (between "A" and "B" leads): 4.8K ohm minimum, 5.8K ohm typical

single-ended ("A" lead to ground with "B" lead grounded): 4.1K ohm minimum, 4.7K ohm typical

Sensitivity: ± 200 mV minimum over common mode voltage range of -7 to +7 volts

Input Hysteresis: 120 mV minimum, 180 mV typical

Table 8-3. RS-449/MIL-188-114/MIL-188C Data Interface
Pin Assignments For 37-Pin Connector

PIN	CIRCUIT	SIGNAL NAME	LEAD STATUS ON DATA INTERFACE	
			EMULATE DTE ("TO DCE")	EMULATE DCE ("TO DTE")
1	SHIELD		internally connected to chassis ground	open*
2	SI	Signaling Rate Indicator	open	open
3	SPARE		open	open
4,22	SD	Send Data	output	input
5,23	ST	Send Timing	input	output
6,24	RD	Receive Data	input	output
7,25	RS	Request To Send	output	input
8,26	RT	Receive Timing	input	output
9,27	CS	Clear To Send	input	output
10	LL	Local Loopback	open	open
11,29	DM	Data Mode	input	output
12,30	TR	Terminal Ready	output	input
13,31	RR	Receiver Ready	input	output
14	RL	Remote Loopback	open	open
15	IC	Incoming Call	input	output
16	SF/SR	Select Frequency/ Signaling Rate Selector	output	input

*May be connected to chassis ground by installing jumper wire JW1 on main PC board.

Table 8-3. (Cont.)

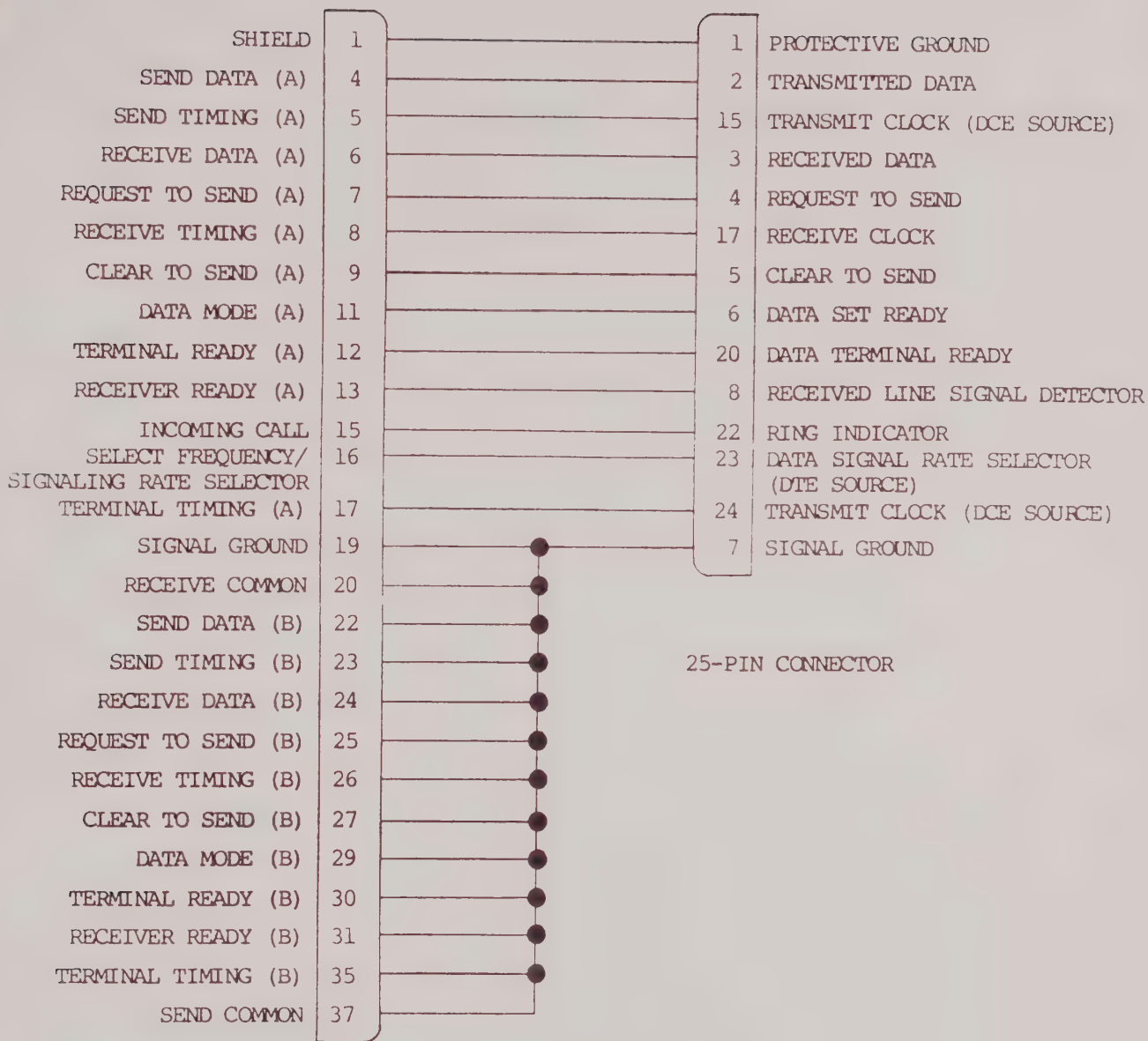
PIN	CIRCUIT	SIGNAL NAME	LEAD STATUS ON DATA INTERFACE	
			EMULATE DTE ("TO DCE")	EMULATE DCE ("TO DTE")
17,35	TT	Terminal Timing	output	input
18	TM	Test Mode	open	output
19	SG	Signal Ground	internally connected to signal ground	
20	RC	Receive Common	input	internally connected to signal ground
21	SPARE		open	open
28	IS	Terminal In Service	output	open
32	SS	Select Standby	open	open
33	SQ	Signal Quality	open	open
34	NS	New Signal	open	open
36	SB	Standby Indicator	open	open
37	SC	Send Common	internally connected to signal ground	input

Note: For Category I circuits the "A" lead is listed First, the "B" lead second.

Table 8-4. RS-449/MIL 188-114/MIL 188C Data Interface
Pin Assignments For 9-Pin Connector

PIN	CIRCUIT	SIGNAL NAME	LEAD STATUS ON DATA INTERFACE	
			EMULATE DTE ("TO DCE")	EMULATE DCE ("TO DTE")
1	SHIELD		internally connected to chassis ground	open *
2	SRR	Secondary Receiver Ready	input	output
3	SSD	Secondary Send Data	output	input
4	SRD	Secondary Receive Data	input	output
5	SG	Signal Ground	internally connected to signal ground	
6	RC	Receive Common	input	internally connected to signal ground
7	SRS	Secondary Request To Send	output	input
8	SCS	Secondary Clear To Send	input	output
9	SC	Send Common	internally connected to signal ground	input

* May be connected to chassis ground by installing jumper wire JW1 on "piggyback" PC board.



37-PIN CONNECTOR

25-PIN CONNECTOR

FIGURE 8-4

37-PIN "D" TO 25-PIN "D" MALE-TO-MALE ADAPTOR CABLE

SECTION 9

INTERNAL PRINTER

9.1 GENERAL

The internal printer is a 20 column alphanumeric printer that is mounted in the right hand side of the front panel. This printer is an option and is either installed at the factory or can be purchased separately and installed by the user.

The printer is used to record results and setup parameters while the DATA SENTRY 10 is performing a test. Refer to Section 7 for further details.

The front panel printer interacts with any other printer connected to the Printer/Remote Controller Interfaces in a manner which is determined by which auxiliary function has been selected. Refer to Section 4 for further details.

9.2 PAPER LOADING

The printer is shipped from the factory with paper installed in the printer. When it is time to replace the paper, the PAPER FEED switch will illuminate and the printer will stop printing. Thermal Printer Paper is available from TTC in 12 roll boxes and its part number is 10217-01.

To replace the paper, follow the step-by-step procedure that follows and refer to Figure 9-1.

1. Turn both of the printers UNLOCK knobs in the direction of the arrows and pull the printer mechanism out of the front panel until the mechanism stops.
2. Raise the load bracket by pulling it forward until it latches. This automatically lifts the thermal printhead from the paper drive roller.
3. Pull the remaining paper out from under the printhead. Grasp the empty paper roll and pull it straight along the axle slot and out of the printer assembly.
4. Slide the paper roll axle out of the used paper roll and insert the axle into the new paper roll. DO NOT DISCARD THE AXLE!
5. Slide the axle (with the new paper roll) into the axle slot and seat the axle in the bottom of the slot. Be sure that the paper is threaded from the rear and passes over the paper roll. The paper should be cut straight for easy insertion.

Only the outside of the paper is treated for printing.
6. Insert the paper in the slot formed by the paper guide and the printhead until paper appears at the front panel opening. Pull paper through front panel slot, close the load bracket

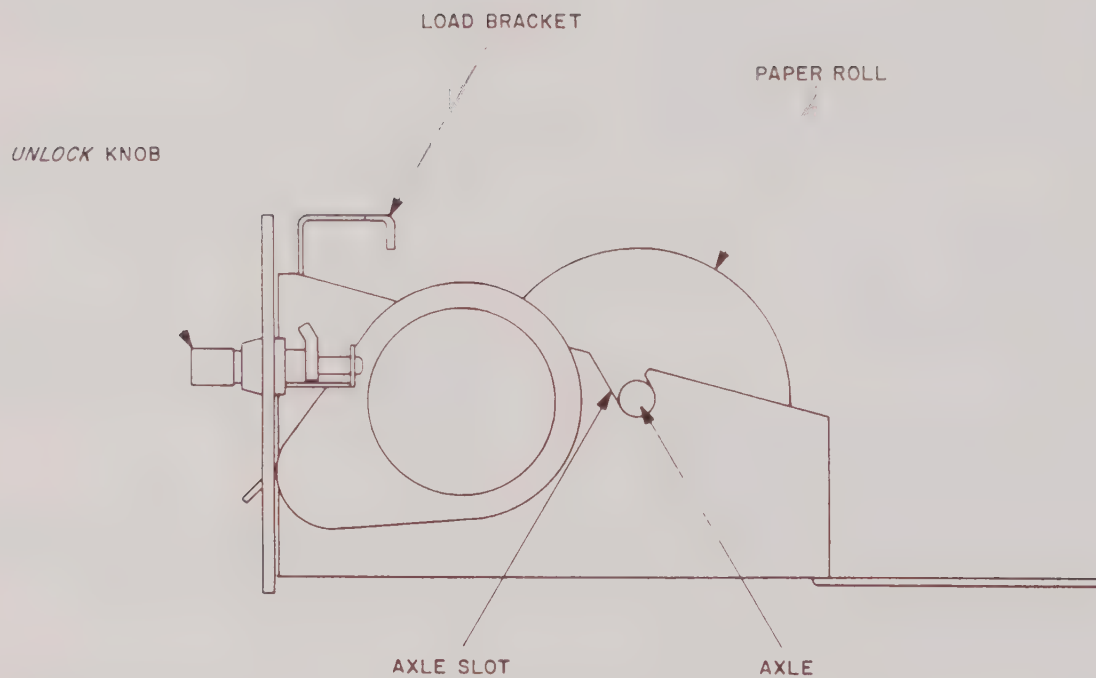


Figure 9-1
INTERNAL PRINTER, SIDE VIEW

by pressing it downwards, and check that the PAPER FEED LED turns off. If not, the paper is not in the proper paper path.

7. Slide the printer head mechanism back into the front panel until it is flush with the panel. Turn the UNLOCK knobs in the opposite direction of the arrows to secure the printer mechanism in the front panel.

9.3 MAINTENANCE

Under normal operating conditions the only maintenance required for the printer is replacing the paper as described above. In some environments periodic cleaning of the print head and driver mechanism may be required. The print head is self cleaning but if dirt should accumulate, clean the print head and drive roller with isopropyl alcohol.

9.4 INSTALLATION AND REMOVAL

This section provides detailed instructions for installing or removing the optional internal printer. The Thermal Printer Option (Option 10387) kit consists of:

1. Printer module assembly
(PL 10387-01) Qty 1
2. Pan head machine screw,
4-40 x 1/4" Lg Qty 5
3. Lock washer, internal teeth,
#4 Qty 5

9.4.1 Installation Procedure

Refer to Figure 9-2. To install the DATA SENTRY 10 Thermal Printer

Option:

1. Remove power source and position the DATA SENTRY 10 on a suitable work surface.
2. Remove the top cover. The top cover is held by two screws securing the top rear extrusion to the rear panel. Remove and save these two screws and slide the extrusion and top rearward.
3. Remove the printer blank-off plate, if installed. Three screws and one nut hold the blank-off plate to the DATA SENTRY 10.
4. Insert the printer assembly through the front panel opening. When the printer is almost completely inserted, the "D" connector at the rear of the printer assembly will start to engage the mating "D" connector on the vertical printed circuit board (Letter A in Figure 9-2). Continue inserting the printer chassis until the "D" connector is engaged. There is a wire harness with a plug (Letter B in Figure 9-2) attached to the printer assembly; this is to be mated to the corresponding receptacle on the vertical printed circuit board. It is keyed and will only mate correctly.
5. The printer chassis has two mounting holes located in the bottom tray. Located on either side of the slot (Letters C in Figure 9-2), they line up with two corresponding threaded

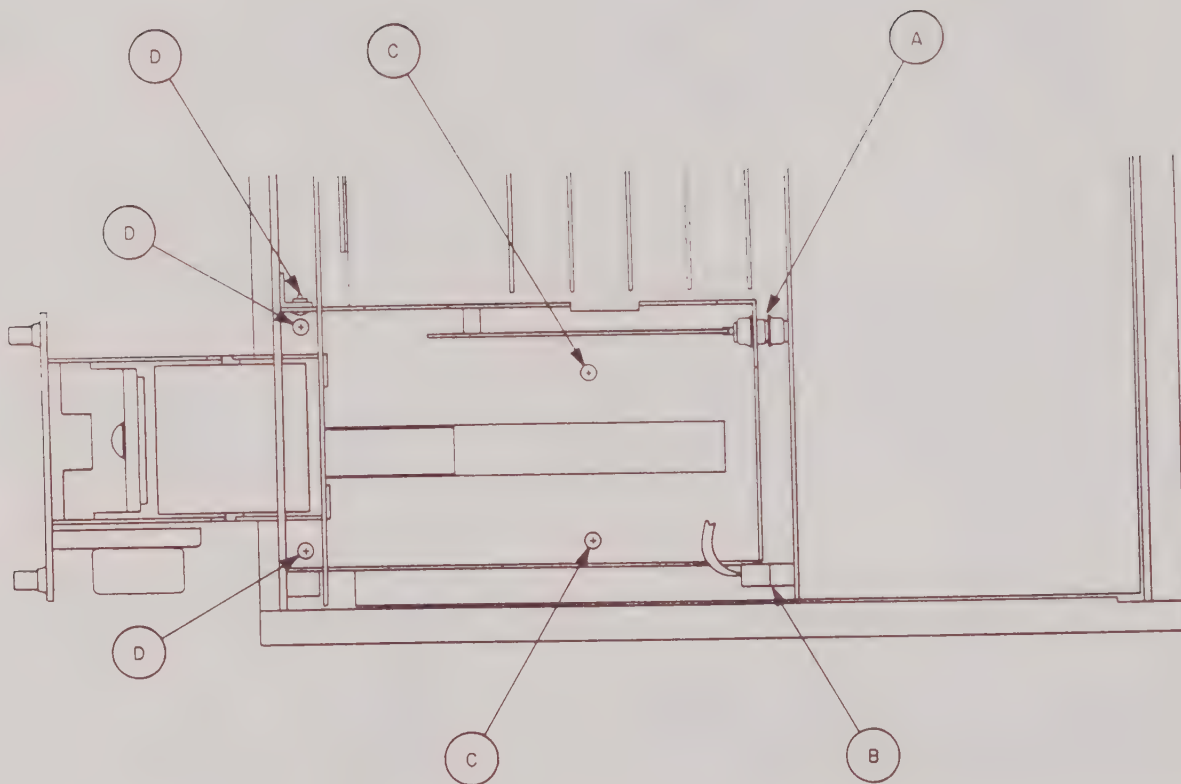


Figure 9-2
PRINTER INSTALLATION, TOP VIEW

standoffs that are mounted in the DATA SENTRY 10 chassis. Install two of the five screws and lock washers. Do not tighten at this time.

6. At the front of the printer chassis there are three mounting holes. They are to line up with three corresponding threaded holes in the brackets mounted against the front panel of the DATA SENTRY 10 (Letters D in Figure 9-2). Install the remaining three screws and lock washers. Do not tighten at this time. The printer panel/mechanism will have to slide forward to provide access to these three mounting screws.
7. Slide the printer mechanism to the "closed" position (flush with the front panel), and engage and tighten the locking pawls located at the left and right side of the printer panel. Tighten the first two screws mounting the chassis.
8. Disengage the printer panel locking pawls and carefully slide the printer mechanism out to the "paper loading" position and tighten the three front mounting screws. Slide the printer to the "closed" position and engage the locking pawls.
9. Slide the DATA SENTRY 10 top cover in place and install the two screws that secure the rear extrusion to the rear panel.

9.4.2 Removal Procedure

Refer to Figure 9-2. To remove the DATA SENTRY 10 Thermal Printer Option:

1. Remove power source and position the DATA SENTRY 10 on a suitable work surface.
2. Remove the top cover. The top cover is held by two screws securing the top rear extrusion to the rear panel. Remove and save these two screws and slide the extrusion and top rearward.
3. Disconnect the printer wire harness plug (at the vertical printed circuit board (Letter B in Figure 9-2)).
4. Remove two screws and lock washers located in the bottom tray of the chassis found on either side of the slot (Letters C in Figure 9-2).
5. Disengage the two locking pawls located on the front of the printer panel and slide outward to the "paper load" position. Remove the three screws and lock washers at the front of the printer chassis which thread into the brackets mounted against the DATA SENTRY 10 panel (Letters D in Figure 9-2).
6. The printer chassis is now ready to slide forward through the DATA SENTRY 10 panel opening. After the "D" connector at the rear is disengaged, the printer chassis will easily slide free of the main unit.
7. Slide the top cover in place and install the two screws that secure the rear extrusion to the rear panel.

SECTION 10

VOICE FREQUENCY MEASUREMENT MODULE

10.1 INTRODUCTION

This section provides information and operating instructions for the Voice Frequency Measurement Module (VF Module). Section 10.2 covers the VF Module's measurement capabilities and Section 10.3 describes techniques for operation. Section 10.4 provides the information necessary to operate the VF Module using remote control. There are two versions, the North American (-01) and CCITT (-02) and the specifications for each are given in Section 10.5. Installation and self test instructions are covered in Section 10.6.

10.2 FUNCTIONAL DESCRIPTION

10.2.1 Introduction

The Voice Frequency Measurement Module consists of a transmitter and receiver operating in the audio frequency range for use in testing telephone transmission lines. The transmitter has a single tone mode for continuous transmission and a sweep mode to cover the audio frequency spectrum. The receiver is capable of tone level, tone frequency, and noise measurements. A notch filter can be used to measure the signal to noise ratio. The receiver also has the ability to receive and store a sweep. After a sweep is received, the channel characteristics may be printed out on the DATA SENTRY 10's printer. Other DATA SENTRY 10 operations may be performed while the VF Module is in use.

10.2.2 The Transmitter

The VF Module's transmitter has a source impedance of 600 ohms and operates through a WECO 310 jack located on the "SEND" side of the VF panel. In operation, the transmitter is controlled through the front panel of the DATA SENTRY 10, or via remote control. A switch on the VF panel ("NORMAL"/"SILENT"), allows the user to turn off the transmitter without changing the DATA SENTRY 10's settings. The transmitter is operated using Auxiliary Function 80.

Two modes of transmission are selectable, single tone and sweep. In both modes the user selects an output level in single dB steps from -40 dBm to +10 dBm. In tone mode a frequency between 200 Hz and 3906 Hz is keyed in, but in sweep mode the frequency automatically changes in 100 Hz steps every 7 seconds from 204 Hz to 3904 Hz. The sweep mode continuously repeats until turned off. In addition, there are two sweep modes -- "ALL" which covers all frequencies mentioned above and "SF SKIP" which skips 2504, 2604, and 2704 Hz. The user should note that whenever the transmitter changes frequency, the output is turned off for 250 msec.

10.2.3 The Receiver

10.2.3.1 Panel

A WECO 310 jack under the "RECEIVE" portion of the Module's panel is the receiver input. The VF Module's input impedance can be changed from 600 ohms to high impedance (bridging) using the center switch on the VF Module's panel ("600 OHMS" or "BRIDGING"). The left-most switch is used to control the power line suppression filter.

10.2.3.2 Filters

Inside the VF Module's receiver there are several weighting filters, listed in Table 10-1. Tone level and frequency measurements are made with a flat filter. Noise measurements are made using one of several selectable filters. Frequency measurements are not made when using noise filters.

10.2.3.2.1 Tone

This filter selection is used to make level and frequency measurements on tones. When "TONE" is selected on the -01 module the signal is measured using an averaging detector. The -02 version uses an RMS detector to measure tone levels.

10.2.3.2.2 3 KHz

This noise filter is a 2-pole low pass filter with a 3 dB point at 3 KHz. It is used when the low frequency components of the noise need to be measured.

10.2.3.2.3 CMSG, PSOM

These filters are used to determine the amount of noise present which would affect telephone communication in the audio spectrum. They are described in Bell PUB 41009 and CCITT Recommendation P. 53.

10.2.3.2.4 CNOT, PNOT

Each of these filter selections is a combination of the previously mentioned filter (CMSG or PSOM), and a notch filter. The frequency of the notch is 1010 Hz for the -01 and 820 Hz for the -02 version. They are typically used to test a channel with a holding tone present or for signal-to-noise measurements. Should the tone level at the frequency of the notch drop below -40 dBm, "TN LOSS" will be displayed on DISPLAY II if it is set to "AUDIO LEVEL".

10.2.4 The VF and the DATA SENTRY 10

Using a VF Module does not interfere with the operation of the DATA SENTRY 10's error analysis but some other conflicts can arise. Some of the DATA SENTRY 10 commands and functions which the user should note include:

1. At power up, the VF Module resumes operation just like the DATA SENTRY 10.
2. The PROG AAA function saves the VF Module's configuration.
3. The synthesizer cannot be in use if the VF Module's transmitter is to be used.

Table 10-1. Receiver Filter Selections

-01 VERSION	-02 VERSION	PURPOSE
10 KHz FLAT (TONE)	10 KHz FLAT (TONE)	TONE LEVEL AND FREQUENCY
3 KHz FLAT (3 KHz)	3 KHz FLAT (3 KHz)	NOISE INCLUDING LOW FREQUENCY
C-MESSAGE (CMSG)	PSOPHOMETER (PSOM)	NOISE MEASUREMENT
C-MESSAGE AND 1010 Hz NOTCH (CNOT)	PSOPHOMETER AND 820 Hz NOTCH (PNOT)	SIGNAL TO NOISE
60 Hz SUPPRESSION	50 Hz SUPPRESSION	REMOVE POWER LINE NOISE

4. The START/RESTART switch does not have any effect on the VF Module's operation.
5. Printouts will inform the reader of the type of VF Module, (-01 or -02) installed, as well as the transmitted and received level and frequency. A controls print will show the transmitter's status, the receiver's filter selection, and the type of VF Module. A results print will show the received level and frequency (if applicable) and will show the results of a sweep if one has been received. Three examples of printouts are shown in Figure 10-1.
6. The audio monitor (internal speaker) can be used to listen to the received input signal. The user may select to turn the audio monitor off using Auxiliary Function 01.
7. The three VF Module panel switches cannot be controlled remotely through the DATA SENTRY 10.

10.3 OPERATION

10.3.1 Introduction

The VF Module is controlled by the DATA SENTRY 10 through the use of Auxiliary Function 80. When Auxiliary Function 80 is selected, a series of options is presented to the user who selects the desired configuration one step at a time. The transmitter's configuration is selected first, the receiver is then set up, and finally DISPLAY II is set up to display either the transmitter's outputs or the received results.

10.3.2 VF Selection Guide

10.3.2.1 General

The VF Selection Guide (Figure 10-2) shows the order of the selections presented and the options available to the user. After entering the Selection Guide, the following keys are used to control the program flow:

10.3.2.1.1 Right Arrow

This key sends you to the menu at the bottom of the chart. From the menu, any place on the chart can be accessed using the SCROLL and ENTER keys.

10.3.2.1.2 Left Arrow

This key has two functions. When entering a level or frequency, it allows incorrect inputs to be retracted. Otherwise, it allows the user to go backwards through the selection guide.

Results Print:

```
17:38:17 17 DEC 89
NO SYNC
RCVR FRQ      0Hz
GEN FRQ       0Hz
BIAS DIST 100% MK
DELAY
VF FRQ        504 Hz
VF LVL      - 1.0dBm
V.35 INTERFACE
RS:T DTR:T
CS:F DSR:F RI:F
RLSD:F
```

Controls Print:

```
17:37:57 17 DEC 89
DATA:      1:1
ERROR INSERT: OFF
MODE:      SELF LOOP
TIMING:     SYNC
GEN CLOCK:  INFC
BER INTERVAL: 10 8
RCVR FUNC: ANALYZE
PRT EVT:TEST INTVL
EMULATE:    DTE
RTS:T DTR:T SR:T
LOCAL:T REMOTE:F
SYNTH FRQ:20.00KHz
DELAY: DTR/ DSR/
PREAM:     NO PREAM
TRAP:      21
HDK DELAYS:
  T1      0ms
  T2      0ms
  T3      0ms
XON CHARACTER: 0D
XOFF CHARACTER: 0A
L FRQ TH: 100.0Hz
U FRQ TH: 200.0Hz
BER ALARM TH: 3E-5
VF MODULE -01:
RECEIVER: CW TONE
TRANSMIT:  TONE
           1000Hz
           -24dB
```

Sweep Results Print:

```
17:42:19 17 DEC 89
NO SYNC      0Hz
RCVR FRQ     0Hz
BIAS DIST 100% MK
DELAY
VF FRQ      204 Hz
VF LVL     -25.0dBm
```

```
VF RCVR SWEEP DATA
..FRQ .....LVL..
  Hz          dBm
```

204	-25.0
303	-16.5
404	-11.4
504	- 7.5
605	- 4.7
704	- 2.7
804	- 1.5
903	- 0.6
1004	- 0.0
1104	- 0.0
1204	- 0.2
1304	- 0.5
1403	- 0.8
1503	- 1.0
1604	- 1.1
1704	- 1.2
1804	- 1.3
1905	- 1.3
2004	- 1.3
2104	- 1.3
2204	- 1.3
2304	- 1.4
2403	- 1.4
2504	- 1.4
2604	- 1.5
2704	- 1.7
2804	- 1.9
2904	- 2.1
3004	- 2.5
3104	- 3.0
3204	- 3.9
3304	- 5.2
3403	- 6.2
3504	- 7.6
3604	- 8.5
3704	- 9.9
3804	-11.4
3904	-12.5

```
V.35 INTERFACE
RS:T DTR:T
CS:F DSR:F RI:F
RLSD:F
SELF LOOP
```

Figure 10-1. Printouts with VF Measurement Module

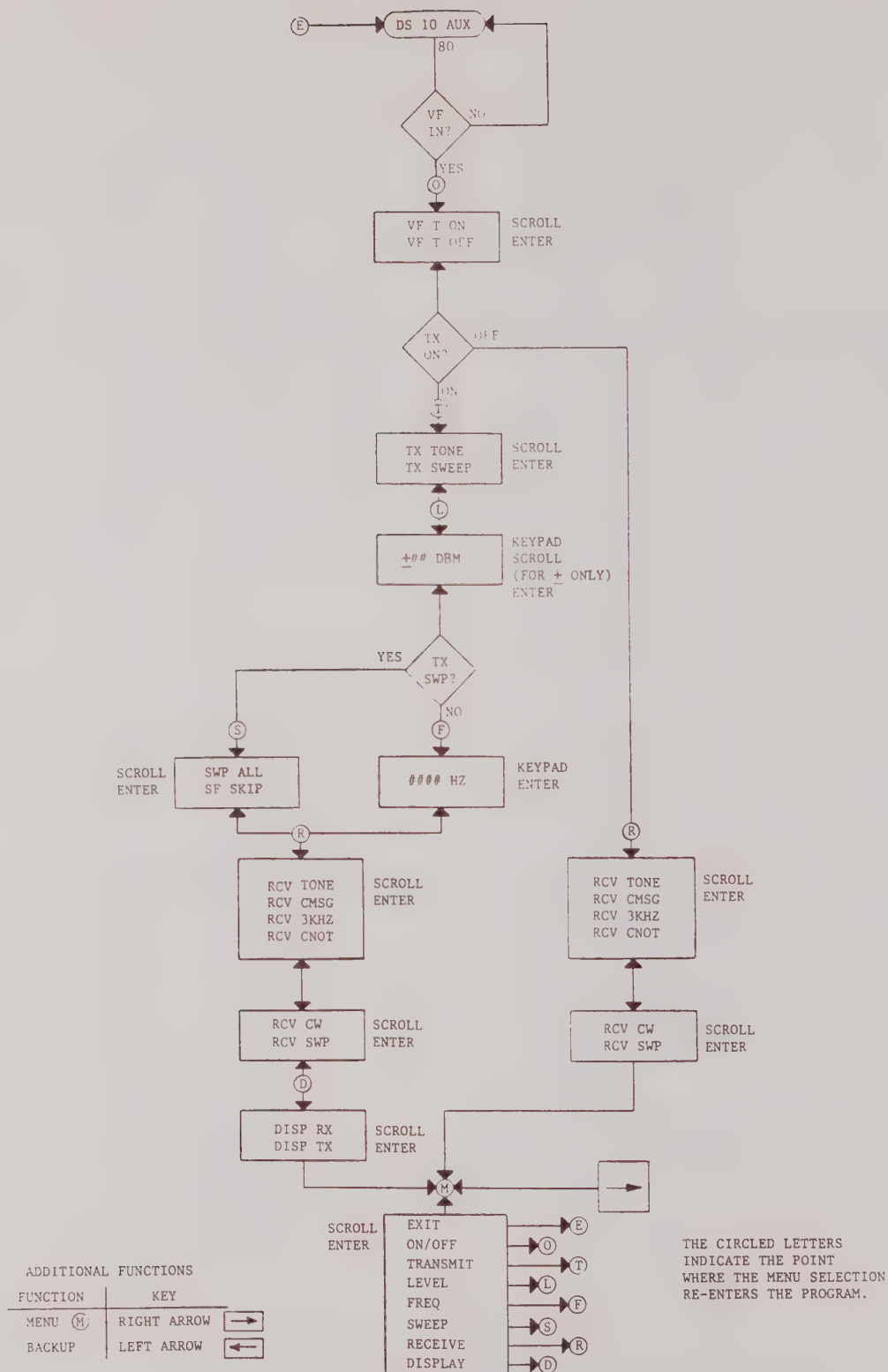


Figure 10-2. Auxiliary Function 80 VF Selection Guide

10.3.2.1.3 SCROLL

When this key is pressed, it will usually operate as described in Section 4.6.2 (Status Select Functions). The SCROLL key is used to change the option displayed and the ENTER key is used to select the displayed option. Also, when setting the level of the transmitter in dBm, the SCROLL key is used to change the sign. This sign changing can only occur when a new level is being entered. Thus to change -10 dBm to +10 dBm, one would enter the sequence 1, 0, SCROLL, ENTER.

10.3.2.1.4 ENTER

When the display is flashing, ENTER selects the flashing option. Otherwise, ENTER will move the user to the next block of options in the selection guide. The first displayed option in each block does not flash, so repeatedly pressing ENTER will cause the user to move through the Selection Guide.

10.3.2.2 Transmitter Selections

10.3.2.2.1 ON/OFF

The first block is used to turn the transmitter on or off. The display will show:

VF T ON or
VF T OFF

Use SCROLL to display the other option, and ENTER to select an option if it is flashing. If the desired option is not flashing, then it is presently selected. Pressing ENTER again will move the user to the next block of options. If "OFF" is

selected, then the rest of the transmitter options are skipped and the results displayed in DISPLAY II are the received results.

10.3.2.2.2 TONE/SWEEP

TX TONE or
TX SWEEP

This block determines the transmitter's mode of operation. These options are selected and displayed as above, but only if the transmitter is on.

10.3.2.2.3 LEVEL

The third block is the level selection, shown in the display as:

± XX DBM

where XX is a number input from the keyboard. The sign may be changed using the SCROLL key, if necessary. In addition, the LEFT ARROW key may be used to retract incorrectly input digits. When ENTER is pressed, the transmitter begins to operate at the new level.

10.3.2.2.4 FREQUENCY

If TX TONE has been selected, the display will then show:

XXXX HZ,

where XXXX is the transmitter's frequency. The frequency is changed by

entering the digits of the new frequency and pressing ENTER. Incorrect inputs may be removed by pressing the LEFT ARROW key before the ENTER key is pressed.

10.3.2.2.5 SWEEP

If TX SWEEP was selected, the display will show:

SWP ALL or
SF SKIP

These options are selected using the SCROLL and ENTER keys.

10.3.2.3 Receiver

The receiver section of the Selection Guide has two parts. The first block consists of filter selections.

-01 Version	-02 Version
RCV TONE	RCV TONE
RCV CMSG	RCV PSOM
RCV 3 KHz	RCV 3 KHz
RCV CNOT	RCV PNOT

The filter is selected using SCROLL and ENTER keys, as above. The next block selects the receiver mode:

RCV TONE or
RCV SWP

These modes are also selected using the SCROLL and ENTER keys.

10.3.2.4 DISPLAY

If VF T OFF was selected above, then this block is skipped and the menu is entered. This block selects what information will be displayed on DISPLAY II.

DISP RX or
DISP TX

The SCROLL and ENTER keys are used to select the desired mode.

10.3.2.5 MENU

The MENU allows the user to re-enter the Selection Guide at almost any point. The MENU can be reached either by pressing ENTER after selecting a display mode, a receive mode if the transmitter is off, or pressing the RIGHT ARROW key at any time. SCROLL is used to view the next selection and ENTER to select the desired option.

10.3.2.5.1 EXIT

EXIT passes the user out of the VF Selection Guide and back into the "AUX" mode of the DATA SENTRY.

10.3.2.5.2 ON/OFF

This selection restarts the Selection Guide at the beginning - selecting VF T ON or VF T OFF. If the transmitter is off and ENTER is pressed, then the menu selections for the transmitter are skipped.

10.3.2.5.3 TRANSMIT

TRANSMIT corresponds to the TONE/ SWEEP portion of the Selection Guide.

10.3.2.5.4 LEVEL

Selecting LEVEL will take the user to the transmitter level selection block.

10.3.2.5.5 FREQ

This selection only appears in the menu if the transmitter is in TONE. It takes the user to the frequency selection block of the Selection Guide.

10.3.2.5.6 SWEEP

This option is only available if the transmitter is in SWEEP mode. It allows the user to select between SWP ALL and SF SKIP.

10.3.2.5.7 RECEIVE

Pressing ENTER for this option takes the user to the receiver selection block.

10.3.2.5.8 DISP R/T

This option, which only appears when the transmitter is on, takes the user to the DISP RX/DISP TX block.

10.3.3 Transmitter Operation

10.3.3.1 Setup

With the VF Module installed, turn on the DATA SENTRY 10. Set the GEN CLK switch to "BNC" or "INTF". Connect the transmitter output to a 600 ohm termination. Set the DISPLAY/ENTRY switch to "AUX" and press 8, 0, ENTER.

10.3.3.2 Tones

Using ENTER, SCROLL, and the keypad, make the following selections:

```
VF T ON
TX TONE
+XX DBM
YYYY HZ
```

where + XX, the level in dBm, may be any number from -40 to +10 and YYYY, the frequency in Hz, may be from 200 to 3906. The backup feature (LEFT ARROW) is very useful if the level and frequency are to be changed often.

10.3.3.3 Sweeps

The sequence of selections to begin a sweep would be as follows:

```
VF T ON
TX SWEEP
+ XX DBM
SWP ALL (or SF SKIP)
```

The transmitter will begin a sweep as soon as TX SWEEP is selected, and the sweep will be restarted if any of the following events occurs:

- * The PWR switch is turned OFF and then ON,
- * The transmitter's level is changed,
- * The type of sweep is changed (ALL/SF SKIP).
- * The transmitter is turned OFF and then ON (VF T OFF/VF T ON).

In this mode, the receiver searches for tones at specific frequencies, stores the level and frequency, and allows a sweep printout using the RESULTS PRINT switch. The results will also be printed when a sweep is complete and the PRINT EVENT switch is set to "TEST INTVL".

10.3.4 Receiver Operation

Once the transmitter's selections have been made, or if VF T OFF has been selected, then the receiver selections may be made. Any of the four filters may be selected in either the continuous mode or the received sweep mode. For best sweep results, the receiver should either be in TONE mode or using the 3 KHz flat filter.

Thus to receive tones, select from the VF Module Selection Guide:

RCV TONE
RCV CW

If the transmitter is ON and you wish to view the receiver's results, then also select:

DISP RX

To receive a sweep, select:

RCV TONE
RCV SWP

10.4 REMOTE CONTROL

10.4.1 Introduction

The VF Module is remotely controllable. See Section 7 to prepare the DATA SENTRY 10 for remote control. While in remote control, the status of the VF Module can be obtained using the CONPRI or RESPRI commands, and the VF Module can be controlled through the AUX 80 command. The switches on the VF panel cannot be changed by remote control.

10.4.2 Command Format

Each of the commands that affects the VF Module will begin with AUX 80. A string of commands may be entered or each function may be addressed separately. The commands are entered as they would be in the VF Selection Guide. Remote control command selections are shown in Table 10-2.

For each command the items demarked by a slash indicate the possible choices and commas demark the series of selections. Only one of the items separated by a slash may be chosen in any command. Items in brackets should be entered as numbers. In a long series of commands, the sequence may stop at any point but the order of inputs cannot change.

The abbreviations are derived from the selection guide and each selection has the same meaning as it does there.

VF T ON, VF T OFF ON/OFF
TX TONE, TX SWEEP TON/SWP
SWP ALL, SF SKIP ALL/SF

RCV TONE, RCV CMSG,
RCV 3 KHz, RCV CNOT TON/CMS/
3 KH/CNO

RCV TONE, RCV PSOM,
RCV 3 KHz, RCV PNOT TON/PSO/
3 KH/PNO

RCV CW, RCV SWP CW/SWP

[LEVEL] and [FREQ] selections set the transmitter level and frequency.

10.4.3 Examples

Various command chains may be used to control the VF Modules transmitter and receiver. For example, to set the transmitter to a -10 dBm, 1000 Hz tone, the receiver to a Tone filter response, and to display the receiver results on Display II:

AUX 80 ON, TON, -10, 1000, TON, CW,
RX

These functions could also be performed separately:

AUX 80 ON
AUX 80 TX, TON
AUX 80 LEV, -10
AUX 80 FRE, 1000
AUX 80 RX, TON, CW
AUX 80 DIS, RX

or they could be grouped differently:

AUX 80 ON
AUX 80 TX, TON, -10, 1000
AUX 80 RX, TON, CW
AUX 80 DIS, RX

Table 10-2. Remote Control Command Options

AUX 80 ON/OFF, TON/SWP, [LEVEL], [FREQ]/ALL/SF, TON/3 KHz/CMS/CNO, CW/SWP

AUX 80 TX, TON/SWP, [LEVEL], [FREQ]/ALL/SF

AUX 80 LEV, [LEVEL]

AUX 80 FRE, [FREQ]

AUX 80 RX, TON/CMS/3 KH/CNO, CW/SWP

AUX 80 DIS, RX/TX

(The -02 version will have PSO and PNO in place of CMS and CNO, respectively.)

10.5 SPECIFICATIONS

10.5.1 General

- 01 Module: * Designed to meet Bell Publication 41009.
- 02 Module: * Designed to meet CCITT specifications.

10.5.2 Transmitter

- Frequency Range: * 200 Hz to 3906 Hz
- Level Range: * +10 dBm to -40 dBm

10.5.2.1 Output

- DC Impedance: * No DC path to ground
- DC Blocking: * 150v
- Output Impedance: * 600 OHMS
- Return Loss: * 30 dB minimum
- Silent Termination: * 600 OHMS, 150v DC Blocking

10.5.2.2 Level and Frequency

- Level Accuracy: * ± 0.2 dB
- Level Resolution: * 1 dB
- Level Stability: * ± 0.05 dB/hour (after 5 minute warm-up)
- Distortion: * ≥ 50 dB below tone
- Frequency Accuracy and Resolution: * 1 Hz

10.5.2.3 Transmit Sweep Mode

- Range:
- * 204 to 3904 Hz in 100 Hz steps, with 4 Hz offset at each step.
 - * SF SKIP skips 2504 Hz, 2604 Hz, and 2704 Hz
- Duration:
- * 7 seconds per step

10.5.3 Receiver

10.5.3.1 Input

- Frequency Range:
- * 80 Hz to 4000 Hz
- DC Impedance to Ground:
- * No DC path to ground
- Terminated Impedance:
- * 600 ohms
- Return Loss:
- * 30 dB minimum
- Bridging Impedance:
- * 25K Ohms minimum
- DC Blocking:
- * 150v DC
- 50 (60) Hz Suppression (Switchable):
- * Attenuation at 400 Hz ... 0 dBm
180 Hz ... 4 dB
60 Hz ... 25 dB

10.5.3.2 Level and Frequency Measurements

- Frequency Range:
- * 80 Hz to 4000 Hz
- Level Range:
- * +10 dBm to -40 dBm
- Resolution:
- * 0.1 dB

Level Accuracy:

- (-01) Averaging Detector:
- * 1000 Hz, 0 dBm to -20 dBm ± 0.1 dB
 - * 200 Hz to 4000 Hz ± 0.2 dB
 - * 80 Hz to 200 Hz ± 0.5 dB

(-02) RMS Detector:

- * 200 Hz to 4000 Hz ± 0.2 dB
- * 80 Hz to 200 Hz ± 0.5 dB

Frequency Resolution:

- * 1 Hz

Frequency Accuracy:

- * ± 1 Hz

10.5.3.3 Noise Measurements

Input Level Range:

- * 15 dBrn to 100 dBrn (-75 to +10 dBm)

Resolution:

- * 1 dB

Accuracy:

- * ± 1 dB

Crest Factor:

- * 8 dB without clipping

Weighting Filters (-01 version):

- * C-Message

(shown in Figure 10-3)

- * C-Message and 1010 Hz Notch

- * 3 KHz Flat

Weighting Filters (-02 version):

- * Psophometer

(shown in Figure 10-3)

- * Psophometer and 820 Hz Notch

- * 3 KHz Flat

10.5.3.4 Receive Sweep Mode

Sweep Range:

- * 104 Hz to 3904 Hz, 1 result every 100 Hz, with 4 Hz offset

Lock In Range:

- * ± 10 Hz at each frequency in range

Result Criterion:

- * 2 consecutive frequency measurements less than 2 Hz apart.

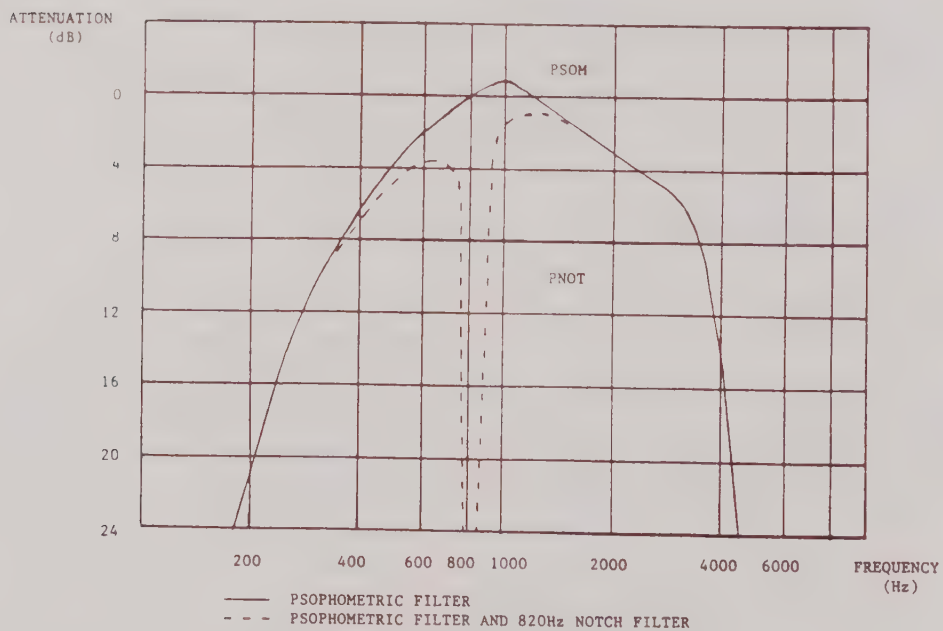
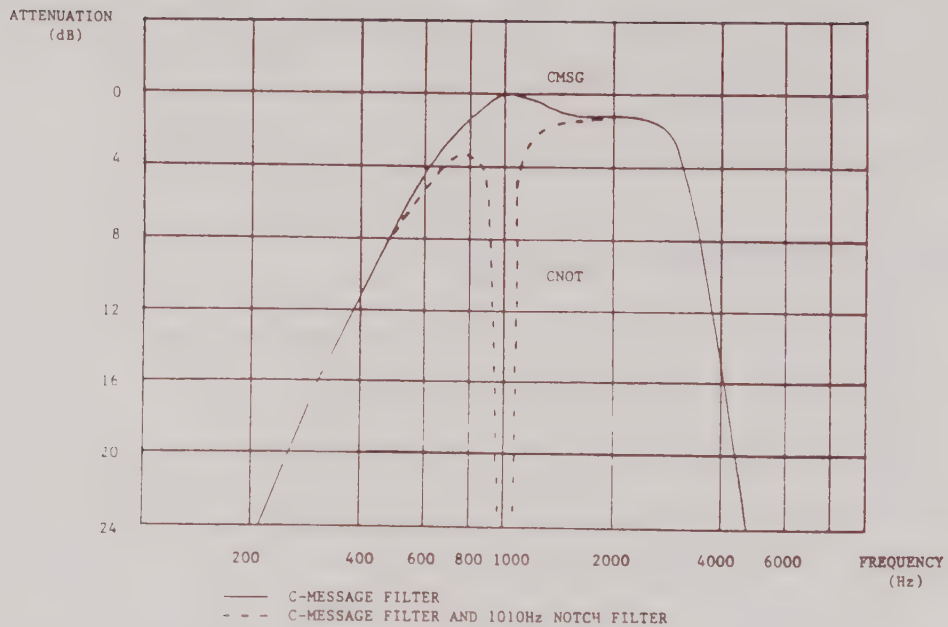


Figure 10-3. Noise Weighting Filters

10.6 INSTALLATION AND SELF TEST

CAUTION

The Voice Frequency Measurement Module should never be installed in or removed from the DATA SENTRY 10 while the power is on. Failure to heed this caution may result in damage which will not be covered by warranty.

10.6.1 Installation Procedure

1. Turn OFF the DATA SENTRY 10.
2. Remove the blank-off plate (if installed) from the opening below the data interface opening.
3. Insert the VF Measurement Module carefully through the rear panel opening. Visually align the PC assembly with the nylon slides and continue sliding the PC assembly until it mates with its connector and the VF Module's panel is flush with the DATA SENTRY 10's rear panel.
4. Secure the module with its captive hardware.

10.6.2 Removal Procedure

1. Turn OFF the DATA SENTRY 10.
2. Loosen captive hardware and firmly slide the VF Measurement Module PC assembly rearward and carefully remove from the opening.

3. Reinstall the blank-off plate.

10.6.3 VF Module Self Test

After the VF Module is installed, a short test can be made to insure that it is operating properly. The following procedure should be performed in sequence because each step assumes the previous steps have been performed. It is assumed that the user has read Section 10.3.

10.6.3.1 Power On

Press the PWR switch to the "ON" position and verify that the Automatic Self Test does not display any error codes in the left-most display. Also verify that several of the switch position LEDs are illuminated.

Set the DISPLAY/ENTRY switch to the "AUX" position, key in "99" and press the ENTER key. This clears all in-use auxiliary functions.

10.6.3.2 Transmit and Receive

Connect a cable with WECO 310 connectors from the VF Module's receiver to its transmitter. Set the two outer switches to the "NORMAL" position and set the center switch to the "600 OHM" position. Make sure that the GEN CLK switch is set to "INTF" or "BNC". With the DISPLAY/ENTRY switch still in "AUX", key in 80 and press ENTER. Using the SCROLL key to change the display and the ENTER key to select the displayed option and move to the next option, select:

VF T ON
TX TONE
-10 DBM
1000 HZ
RCV TONE
RCV CW
DISP RX

If an incorrect entry is made, back up using the LEFT ARROW key. If too many entries are made and the menu is displayed, then select EXIT and start over again or select the appropriate spot from the Menu to correct any mistakes that were made and continue from there. Set the DISPLAY II switch to "AUDIO FREQ (Hz)", and verify that the rightmost display shows 1000 Hz. Set the DISPLAY II switch to "AUDIO LEVEL", and observe the rightmost display which should read about -10.0 dBm.

10.6.3.3 Sweep Measurements

Set the DISPLAY II switch to "AUDIO FREQ (Hz)". With the left most display showing "DISP RX", press ENTER, SCROLL, ENTER to go to the top of the VF Selection Guide. The display should read "VF T ON". Select the following options:

"VF T ON"
"TX SWEEP"
"-10 DBM"
"SWP ALL"
"RCV TONE"
"RCV SWP"

DISPLAY II should show the frequencies from 204 Hz to 3904 Hz displayed in 100 Hz steps changing every 7 seconds. When the sweep returns to 204 Hz to begin again, set the PRINT EVENT switch to "TEST INTVL" to obtain a copy of the results, if desired.

SECTION 11

OPTIONS AND ACCESSORIES

11.1 INTRODUCTION

In this section, some of the options and accessories available for the DATA SENTRY 10 are described. Installation and removal instructions for some options and accessories are provided in this section. Because detailed technical descriptions of some options and accessories are provided elsewhere in this manual, the reader will be referred to other manual sections for these descriptions.

11.2 RACK MOUNT KIT (Model 10413)

The Rack Mount Kit allows the DATA SENTRY 10 to be installed in a standard 19-inch electronic enclosure. The Rack Mount Kit consists of two brackets and assembly hardware. Installation can be accomplished with a screwdriver in approximately 20 minutes.

The kit consists of two brackets (part no. 30369), eight 10-32 flat head machine screws 7/8" long, and eight standard 10-32 hex nuts. To install and assemble the Rack Mount Kit:

1. Disconnect power cord.
2. Remove top and bottom covers by removing the two screws attaching top and bottom rear extruded bezels, and slide the bezel/cover assemblies to the rear. Remove the twist lock bumpers (4 each side) by gently prying. Remove the decorative strips

(2 each side) by carefully pushing, from the inside, through the hole in the hex cavity with a 1/8 diameter rod or similar object. This will separate the Velcro fastening strips.

3. The brackets each have 4 holes that correspond with 4 holes in the side of the instrument (through the Velcro patches). Assemble the bracket with two screws and two nuts using the top holes first. Note that the nuts fit into hex cavities on the inside surface of the side plate.

Install the bottom screws and nuts. Note that the hex nuts will present a snug fit but will fit into the hex cavities without loosening the assembly. Tighten the screws.

4. Reinstall top and bottom cover/extrusion assemblies using the screws removed in step 2. Unit is ready to rack mount. Rack mount screws (4) are not provided.

11.3 SOFT CARRYING CASE (Model 10412)

The Soft Carrying Case provides a lightweight method of carrying the DATA SENTRY 10 and accessories while giving the instrument some protection against everyday bumps and bruises. The case is constructed from navy blue canvas with foam padding built in all sides, top and bottom. The approximate outside dimensions are 20" wide x 9 1/2" deep x 19 1/2" high. (51 x 24 x 50 cm.) The top is

hinged and secures with Velcro. Web handles support across the bottom and both sides. There is an inside pocket for the manual and two additional Data Interfaces. The modules have individual protective wrap. Weight is 6 1/2 lbs. (3 kg), empty.

11.4 HARD SHIPPING CASE (Model 10411)

The Hard Shipping Case provides a rugged protective case for the DATA SENTRY 10 and its accessories. The shipping case is constructed from molded black ABS plastic as two shells hinged on one side and mated with a tongue and groove valance. It is equipped with draw catches and a carrying handle, and is similar in appearance to a large suitcase.

The interior is fitted with a dark gray polyurathane foam liner with cavities cut out for the DATA SENTRY 10, a holder for three additional Data Interfaces, and three accessory cables. The manual stores under the DATA SENTRY 10.

The dimensions are approximately 21" wide x 31" long x 8" high. (53 x 79 x 20 cm.) Weight is 18 lbs (8 kg), empty.

11.5 HIGH STABILITY TIME BASE (Option 10454)

The standard time base supplied with the DATA SENTRY 10 has a total inaccuracy (initial accuracy plus stability over the test set's operating temperature range) of ± 35 ppm. The High Stability Time Base option allows the total inaccuracy to be reduced to ± 7 ppm.

The time base is used by the DATA SENTRY 10 as a reference standard for the frequency and delay measurement circuitry and for the frequency synthesizer and clock recovery circuitry. The effect of time base accuracy on frequency measurements is discussed in Section 5.3.14.

The High Stability Time Base option may be installed by the user; contact TTC for retrofit instructions.

SECTION 12

MAINTENANCE AND SERVICE

12.1 IN CASE OF DIFFICULTY

If the DATA SENTRY 10 fails to operate and no front panel indicators illuminate, check the AC power supply, the AC power cord, and the AC fuse and fuse size (See Section 3.4).

If some indicators light but the unit fails to operate, verify that the Data Interface in use is the correct type and properly inserted. Check the interface cabling and the connections to the DATA SENTRY 10.

Follow the Manual Self Test procedure in Section 3.3 as an aid to localizing the problem. If the unit fails its Automatic Self Test or if the unit cannot be made to function properly, refer to the following sections for service information.

12.2 WARRANTY POLICY

All equipment manufactured by Telecommunications Techniques Corporation (TTC) is warranted against defects in material and workmanship. This warranty applies only to the original purchaser and is non-transferable unless express written authorization of the warranty transfer is granted by TTC.

The DATA SENTRY 10 will be repaired or replaced (at our option) at no charge for a period of one year after shipment to the customer. Liability under this warranty extends only to the replacement value of the equipment. The warranty is void under the following conditions.

1. Equipment has been altered or repaired without specific authorization by TTC.
2. Equipment is installed or operated other than in accordance with instructions contained in TTC literature and operating manuals.

No other warranty is expressed or implied. TTC is not liable for consequential damages.

12.3 IN-WARRANTY SERVICE

Equipment in warranty must be returned to the factory with shipping prepaid. The equipment should be packed and shipped in accordance with the instructions in Section 12.5 of this manual. Before returning any equipment, the customer must obtain a Return Authorization (RA) number by contacting the TTC Repair Department. The RA number should then appear on all paperwork and be clearly marked on the outside of the shipping container.

After the equipment is repaired by TTC, it will be tested to applicable specifications, burned-in for at least 24 hours, retested, and returned to the customer with shipping prepaid. A brief description of the work performed and the materials used will be provided on the Equipment Repair Report furnished with the returned equipment.

12.4 OUT-OF-WARRANTY SERVICE

The procedure for repairing out-of-warranty equipment is the same as that used for equipment still in warranty. However, there is a minimum charge applied to each request for out-of-warranty service. The minimum charge guarantees the customer an estimate of the repair costs and is used as a credit against actual materials and labor costs should the equipment be repaired. Contact the IFC Repair Department for specific information on the minimum out-of-warranty repair charge.

The customer will be billed for parts plus standard labor rates in effect at the time of repair. The customer will also be required to furnish a purchase order number before repair work can be started, and a hard copy of the purchase order must be received by IFC before the repaired equipment may be shipped to the customer. A description of the labor and materials used will be provided in the Equipment Repair Report.

Once an out-of-warranty repair is made, the repaired part or component is warranted for 90 days. This warranty applies only to the part or component that was repaired; other parts or components are not covered under the 90-day repair warranty.

12.5 REPACKAGING FOR SHIPMENT

For all equipment returned for repair, the customer should attach a tag that includes the following information.

- (1) Owners's name and address.
- (2) A list of the equipment being returned and the applicable serial number(s).

- (3) A detailed description of the problem or service requested.
- (4) The name and telephone of the person to contact regarding questions about the repair.
- (5) The Return Authorization (RA) number.

If possible, the customer should return the equipment using the original shipping container and material. If the original container is not available, the unit should be carefully packed so that it will not be damaged in transit. IFC is not liable for any damage that may occur during shipping. The customer should clearly mark the IFC-issued RA number on the outside of the package and ship it prepaid and insured to IFC.

APPENDIX A

ABBREVIATIONS

ACT	Activity
ASCII	American Standard Code for Information Exchange
ASYN	Asynchronous
AUX	Auxiliary
BCDIC	Binary Coded Decimal Interchange Code
BER	Bit Error Rate
BLK	Block
bps	bits per second
CCITT	International Consultative Committee for Telegraphy and Telephony
CD	Carrier Detect
CHAR	Character
CLK	Clock
CS	Clear to Send
CTS	Clear to Send
dB	decibel
dBm	decibels relative to 1 milliwatt
DCE	Data Communications Equipment
DM	Data Mode
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EBCDIC	Extended Binary Coded Decimal Interchange Code
EIA	Electronic Industries Association
ERR	Error
EXT	External
FDX	Full Duplex
FIFO	First-In, First-Out (buffer)
FREQ	Frequency
GEN	Generator
GND	Ground
HDX	Half Duplex
Hz	Hertz

APPENDIX A

(CONTINUED)

IEEE	Institute of Electrical and Electronics Engineers
INTF	Interface
INTVL	Interval
INW	Invert
kbps	kilobits per second
kHZ	kilohertz
LED	Light Emitting Diode
LVL	Level
mA	milliampere
MAX	Maximum
MIN	Minimum, Minute
MK	Mark
ms	millisecond
mV	millivolt
pp	peak to peak
ppm	parts per million
PREAM	Preamble
RCV	Receive
RCVR	Receiver
RI	Ring Indicator
RLSD	Received Line Signal Detect
RR	Receiver Ready
RS	Request to Send
RTS	Request to Send
SEC	Second
SNGL	Single
SP	Space
SR	Signaling Rate
SYNC	Synchronous, Synchronization
SYNTH	Synthesizer

APPENDIX A

(CONTINUED)

TR	Terminal Ready
TTC	Telecommunications Techniques Corporation
TX	Transmit

v	volt
---	------

APPENDIX B. HEX CONVERSION TABLE

HEX	BAUDOT		EBCDIC		ASCII	EBCDIC
	LTRS	FIGS	UPPER	LOWER		
00	Blank	Blank	Space	Space	NUL (Blank)	NUL (Null)
01	E	3	=	1	SOH (Start of Header)	SOH (Start of Header)
02	LF	LF	<	2	STX (Start of Text)	STX (Start of Text)
03	A	-	:	3	ETX (End of Text)	ETX (End of Text)
04	Space	Space	:	4	EOF (End of Transmission)	PF (Punch Off)
05	S	' or BELL	:	5	ENQ (Enquiry)	HT (Horizontal Tab)
06	I	8	:	6	ACK (Acknowledge)	LC (Lower Case)
07	J	7	>	7	BEL (Bell)	DEL (Delete)
08	CR	CR	*	8	BS (Backspace)	
09	D	WRU or \$	(	9	HT (Horizontal Tabulation)	RLF
0A	R	4	)	0	LF (Line Feed)	SMM (Start Manual Message)
0B	J	BELL or	"	#	VT (Vertical Tabulation)	VT (Vertical Tab)
0C	N	:	DC2	DC2	FF (Form Feed)	FF (Form Feed)
0D	F	:	RS	RS	CR (Carriage Return)	CR (Carriage Return)
0E	C	:	UPPER	UPPER	SO (Shift Out)	SO (Shift Out)
0F	K	:	EOF	EOF	SI (Shift In)	SI (Shift In)
10	T	5	CAN	a	DLE (Data Link Escape)	DLE (Data Link Escape)
11	Z	+ or "	?	a	DC1 (Device Control 1)	DC1 (Device Control 1)
12	L	:	S	s	DC2 (Device Control 2)	DC2 (Device Control 2)
13	W	2	T	t	DC3 (Device Control 3)	DC3 (Device Control 3)
14	H	#	U	u	DC4 (Device Control 4)	RES (Restore)
15	Y	6	V	v	NAK (Negative Acknowledge)	NL (New Line)
16	P	0	W	w	SYN (Synchronization)	BS (Backspace)
17	Q	1	X	x	ETB (End of Text Block)	IL (Idle)
18	O	9	Y	y	CAN (Cancel)	CAN (Cancel)
19	B	?	Z	z	EM (End of Medium)	EM (End of Medium)
1A	G	&	.	.	SUB (Substitute)	CC (Cursor Control)
1B	FIGS	FIGS	,	,	ESC (Escape)	CUI (Customer Use 1)
1C	M	:	BEL	BEL	FS (File Separator)	IFS (Interchange File Sep.)
1D	X	/	LF	LF	GS (Group Separator)	IGS (Interchange Group Sep.)
1E	V	= or ;	ETB	ETB	RS (Record Separator)	IRS (Interchange Record Sep.)
1F	LTRS	LTRS	DC3	DC3	US (Unit Separator)	IUS (Interchange Unit Sep.)

HEX	BAUDOT		EBCDIC		ASCII	EBCDIC
	LTRS	FIGS	UPPER	LOWER		
20	Blank	Blank	-	-	SP	DS (Digit Select)
21	E	3	J	j	:	SOS (Start of Significance)
22	LF	LF	K	k	"	FS (Field Separator)
23	A	-	L	l	#	
24	Space	Space	M	m	\$	EYP (Bypass)
25	S	' or BELL	N	n	%	LF (Line Feed)
26	I	8	O	o	&	ETB (End Transmission Block)
27	U	7	P	p	' (Single Closing Quote)	ESC (Escape)
28	CR	CR	Q	q	(	
29	D	WRU or \$	R	r	)	
2A	R	4	.	.	*	SM (Set Mode)
2B	J	BELL or	:	\$	+	CU2 (Customer Use 2)
2C	N	:	DC4	DC4	, (Comma)	
2D	F	:	CR	CR	- (Hyphen)	ENQ (Enquiry)
2E	C	:	BS	BS	. (Period)	ACK (Acknowledge)
2F	K	:	DLE	DLE	/	BEL (Bell)
30	T	5	+	&	0	
31	Z	+ or "	A	a	1	
32	L	)	B	b	2	SYN (Synchronous Idle)
33	W	2	C	c	3	
34	H	#	D	d	4	PN (Punch On)
35	Y	6	E	e	5	RS (Reader Stop)
36	P	0	F	f	6	UC (Upper Case)
37	Q	1	G	g	7	EOF (End of Transmission)
38	O	9	H	h	8	
39	B	?	I	i	9	
3A	G	&	.	.	:	
3B	FIGS	FIGS	,	,	; ;	CU3 (Customer Use 3)
3C	M	:	DC1	DC1	< (Less Than)	DC4 (Device Control 4)
3D	X	/	HT	HT	=	NAK (Negative Acknowledge)
3E	V	= or ;	LOWER	LOWER	> (Greater Than)	
3F	LTRS	LTRS	DEL	DEL	?	SUB (Substitute)

HEX CONVERSION TABLE (CONTINUED)

HEX	ASCII		EBCDIC		ASCII	EBCDIC
	CHAR	HEX	CHAR	HEX		
00	Blank	Blank	Space	Space	0	SP (Space)
01	A	A	1	1	A	
02	B	B	2	2	B	
03	C	C	3	3	C	
04	D	D	4	4	D	
05	E	E	5	5	E	
06	F	F	6	6	F	
07	G	G	7	7	G	
08	H	H	8	8	H	
09	I	I	9	9	I	
0A	J	J	0	0	J	.
0B	K	K	1	1	K	< (Less Than)
0C	L	L	2	2	L	(
0D	M	M	3	3	M	+
0E	N	N	4	4	N	(Logical OR)
0F	O	O	5	5	O	
10	P	P	6	6	P	
11	Q	Q	7	7	Q	
12	R	R	8	8	R	
13	S	S	9	9	S	
14	T	T	0	0	T	
15	U	U	1	1	U	
16	V	V	2	2	V	
17	W	W	3	3	W	
18	X	X	4	4	X	
19	Y	Y	5	5	Y	
1A	Z	Z	6	6	Z	
1B	[	[	7	7	[	
1C	\	\	8	8	\	
1D	]	]	9	9	]	
1E	^	^	0	0	^	
1F	_	_	1	1	_	
20	`	`	2	2	`	
21	a	a	3	3	a	
22	b	b	4	4	b	
23	c	c	5	5	c	
24	d	d	6	6	d	
25	e	e	7	7	e	
26	f	f	8	8	f	
27	g	g	9	9	g	
28	h	h	0	0	h	
29	i	i	1	1	i	
2A	j	j	2	2	j	
2B	k	k	3	3	k	
2C	l	l	4	4	l	
2D	m	m	5	5	m	
2E	n	n	6	6	n	
2F	o	o	7	7	o	
30	p	p	8	8	p	
31	q	q	9	9	q	
32	r	r	0	0	r	
33	s	s	1	1	s	
34	t	t	2	2	t	
35	u	u	3	3	u	
36	v	v	4	4	v	
37	w	w	5	5	w	
38	x	x	6	6	x	
39	y	y	7	7	y	
3A	z	z	8	8	z	
3B	{	{	9	9	{	
3C			0	0		
3D	}	}	1	1	}	
3E	~	~	2	2	~	
3F	DEL	DEL	3	3	DEL	

HEX	ASCII		EBCDIC		ASCII	EBCDIC
	CHAR	HEX	CHAR	HEX		
40	`	`	2	2	`	
41	a	a	3	3	a	
42	b	b	4	4	b	
43	c	c	5	5	c	
44	d	d	6	6	d	
45	e	e	7	7	e	
46	f	f	8	8	f	
47	g	g	9	9	g	
48	h	h	0	0	h	
49	i	i	1	1	i	
4A	j	j	2	2	j	
4B	k	k	3	3	k	
4C	l	l	4	4	l	
4D	m	m	5	5	m	
4E	n	n	6	6	n	
4F	o	o	7	7	o	
50	p	p	8	8	p	
51	q	q	9	9	q	
52	r	r	0	0	r	
53	s	s	1	1	s	
54	t	t	2	2	t	
55	u	u	3	3	u	
56	v	v	4	4	v	
57	w	w	5	5	w	
58	x	x	6	6	x	
59	y	y	7	7	y	
5A	z	z	8	8	z	
5B	{	{	9	9	{	
5C			0	0		
5D	}	}	1	1	}	
5E	~	~	2	2	~	
5F	DEL	DEL	3	3	DEL	

HEX CONVERSION TABLE (CONTINUED)

HEX	BAUDOT		BODIC		ASCII	EBCDIC
	LTRS	FIGS	UPPER	LOWER		
80	Blank	Blank	Space	Space	NUL (Blank)	
81	E	3	=	1	SOH (Start of Header)	a
82	LF	LF	<	2	STX (Start of Text)	b
83	A	-	:	3	ETX (End of Text)	c
84	Space	Space	:	4	EOT (End of Transmission)	d
85	S	; or BELL	;	5	ENQ (Enquiry)	e
86	I	8	'	6	ACK (Acknowledge)	f
87	U	7	>	7	BEL (Bell)	g
88	CR	CR	*	8	BS (Backspace)	h
89	D	WRU or \$	(	9	HT (Horizontal Tabulation)	i
8A	R	4	)	0	LF (Line Feed)	
8B	J	BELL or	"	#	VT (Vertical Tabulation)	
8C	N	,	DC2	DC2	FF (Form Feed)	
8D	F	:	RS	RS	CR (Carriage Return)	
8E	C	:	UPPER	UPPER	SO (Shift Out)	
8F	K	(	EOT	EOT	SI (Shift In)	
90	T	5	CAN	;	DLE (Data Link Escape)	
91	Z	+ or "	?	/	DC1 (Device Control 1)	j
92	L	)	S	s	DC2 (Device Control 2)	k
93	W	2	T	t	DC3 (Device Control 3)	l
94	H	#	U	u	DC4 (Device Control 4)	m
95	Y	6	V	v	NAK (Negative Acknowledge)	n
96	P	0	W	w	SYN (Synchronization)	o
97	Q	1	X	x	ETB (End of Text Block)	p
98	O	9	Y	y	CAN (Cancel)	q
99	B	?	Z	z	EM (End of Medium)	r
9A	G	&			SUB (Substitute)	
9B	FIGS	FIGS	,	,	ESC (Escape)	
9C	M	.	BEL	BEL	FS (File Separator)	
9D	X	/	LF	LF	GS (Group Separator)	
9E	V	= or :	ETB	ETB	RS (Record Separator)	
9F	LTRS	LTRS	DC3	DC3	US (Unit Separator)	

HEX	BAUDOT		BODIC		ASCII	EBCDIC
	LTRS	FIGS	UPPER	LOWER		
A0	Blank	Blank	-	-	SP (Space)	-
A1	E	3	J	j	:	s
A2	LF	LF	K	k	"	t
A3	A	-	L	l	#	u
A4	Space	Space	M	m	\$	v
A5	S	; or BELL	N	n	%	w
A6	I	8	O	o	&	x
A7	U	7	P	p	' (Single Closing Quote)	
A8	CR	CR	Q	q	(	y
A9	D	WRU or \$	R	r	)	z
AA	R	4			*	
AB	J	BELL or	:	\$	+ .	
AC	N	,	DC4	DC4	, (Comma)	
AD	F	:	CR	CR	- (Hyphen)	
AE	C	:	BS	BS	. (Period)	
AF	K	(	DLE	DLE	/	
B0	T	5	+	&	0	
B1	Z	+ or "	A	a	1	
B2	L	)	B	b	2	
B3	W	2	C	c	3	
B4	H	#	D	d	4	
B5	Y	6	E	e	5	
B6	P	0	F	f	6	
B7	Q	1	G	g	7	
B8	O	9	H	h	8	
B9	B	?	I	i	9	
BA	G	&			:	
BB	FIGS	FIGS	.	.	:	
BC	M	.	DC1	DC1	< (Less Than)	
BD	X	/	HT	HT	=	
BE	V	= or :	LOWER	LOWER	> (Greater Than)	
BF	LTRS	LTRS	DEL	DEL	?	

HEX CONVERSION TABLE (CONTINUED)

HEX	ASCII		EBCDIC		ASCII	EBCDIC
	UPPER	LOWER	UPPER	LOWER		
00	Blank	Blank	Space	Space	0	(
01	"	"	"	"	A	A
02	LF	LF	"	"	B	B
03	"	"	"	"	C	C
04	Space	Space	"	"	D	D
05	"	"	"	"	E	E
06	"	"	"	"	F	F
07	"	"	"	"	G	G
08	"	"	"	"	"	"
09	"	"	"	"	"	"
0A	"	"	"	"	"	"
0B	"	"	"	"	"	"
0C	"	"	"	"	"	"
0D	"	"	"	"	"	"
0E	"	"	"	"	"	"
0F	"	"	"	"	"	"
10	"	"	"	"	"	"
11	"	"	"	"	"	"
12	"	"	"	"	"	"
13	"	"	"	"	"	"
14	"	"	"	"	"	"
15	"	"	"	"	"	"
16	"	"	"	"	"	"
17	"	"	"	"	"	"
18	"	"	"	"	"	"
19	"	"	"	"	"	"
1A	"	"	"	"	"	"
1B	"	"	"	"	"	"
1C	"	"	"	"	"	"
1D	"	"	"	"	"	"
1E	"	"	"	"	"	"
1F	"	"	"	"	"	"
20	"	"	"	"	"	"
21	"	"	"	"	"	"
22	"	"	"	"	"	"
23	"	"	"	"	"	"
24	"	"	"	"	"	"
25	"	"	"	"	"	"
26	"	"	"	"	"	"
27	"	"	"	"	"	"
28	"	"	"	"	"	"
29	"	"	"	"	"	"
2A	"	"	"	"	"	"
2B	"	"	"	"	"	"
2C	"	"	"	"	"	"
2D	"	"	"	"	"	"
2E	"	"	"	"	"	"
2F	"	"	"	"	"	"
30	"	"	"	"	"	"
31	"	"	"	"	"	"
32	"	"	"	"	"	"
33	"	"	"	"	"	"
34	"	"	"	"	"	"
35	"	"	"	"	"	"
36	"	"	"	"	"	"
37	"	"	"	"	"	"
38	"	"	"	"	"	"
39	"	"	"	"	"	"
3A	"	"	"	"	"	"
3B	"	"	"	"	"	"
3C	"	"	"	"	"	"
3D	"	"	"	"	"	"
3E	"	"	"	"	"	"
3F	"	"	"	"	"	"
40	"	"	"	"	"	"
41	"	"	"	"	"	"
42	"	"	"	"	"	"
43	"	"	"	"	"	"
44	"	"	"	"	"	"
45	"	"	"	"	"	"
46	"	"	"	"	"	"
47	"	"	"	"	"	"
48	"	"	"	"	"	"
49	"	"	"	"	"	"
4A	"	"	"	"	"	"
4B	"	"	"	"	"	"
4C	"	"	"	"	"	"
4D	"	"	"	"	"	"
4E	"	"	"	"	"	"
4F	"	"	"	"	"	"
50	"	"	"	"	"	"
51	"	"	"	"	"	"
52	"	"	"	"	"	"
53	"	"	"	"	"	"
54	"	"	"	"	"	"
55	"	"	"	"	"	"
56	"	"	"	"	"	"
57	"	"	"	"	"	"
58	"	"	"	"	"	"
59	"	"	"	"	"	"
5A	"	"	"	"	"	"
5B	"	"	"	"	"	"
5C	"	"	"	"	"	"
5D	"	"	"	"	"	"
5E	"	"	"	"	"	"
5F	"	"	"	"	"	"
60	"	"	"	"	"	"
61	"	"	"	"	"	"
62	"	"	"	"	"	"
63	"	"	"	"	"	"
64	"	"	"	"	"	"
65	"	"	"	"	"	"
66	"	"	"	"	"	"
67	"	"	"	"	"	"
68	"	"	"	"	"	"
69	"	"	"	"	"	"
6A	"	"	"	"	"	"
6B	"	"	"	"	"	"
6C	"	"	"	"	"	"
6D	"	"	"	"	"	"
6E	"	"	"	"	"	"
6F	"	"	"	"	"	"
70	"	"	"	"	"	"
71	"	"	"	"	"	"
72	"	"	"	"	"	"
73	"	"	"	"	"	"
74	"	"	"	"	"	"
75	"	"	"	"	"	"
76	"	"	"	"	"	"
77	"	"	"	"	"	"
78	"	"	"	"	"	"
79	"	"	"	"	"	"
7A	"	"	"	"	"	"
7B	"	"	"	"	"	"
7C	"	"	"	"	"	"
7D	"	"	"	"	"	"
7E	"	"	"	"	"	"
7F	"	"	"	"	"	"
80	"	"	"	"	"	"
81	"	"	"	"	"	"
82	"	"	"	"	"	"
83	"	"	"	"	"	"
84	"	"	"	"	"	"
85	"	"	"	"	"	"
86	"	"	"	"	"	"
87	"	"	"	"	"	"
88	"	"	"	"	"	"
89	"	"	"	"	"	"
8A	"	"	"	"	"	"
8B	"	"	"	"	"	"
8C	"	"	"	"	"	"
8D	"	"	"	"	"	"
8E	"	"	"	"	"	"
8F	"	"	"	"	"	"
90	"	"	"	"	"	"
91	"	"	"	"	"	"
92	"	"	"	"	"	"
93	"	"	"	"	"	"
94	"	"	"	"	"	"
95	"	"	"	"	"	"
96	"	"	"	"	"	"
97	"	"	"	"	"	"
98	"	"	"	"	"	"
99	"	"	"	"	"	"
9A	"	"	"	"	"	"
9B	"	"	"	"	"	"
9C	"	"	"	"	"	"
9D	"	"	"	"	"	"
9E	"	"	"	"	"	"
9F	"	"	"	"	"	"
AA	"	"	"	"	"	"
AB	"	"	"	"	"	"
AC	"	"	"	"	"	"
AD	"	"	"	"	"	"
AE	"	"	"	"	"	"
AF	"	"	"	"	"	"
B0	"	"	"	"	"	"
B1	"	"	"	"	"	"
B2	"	"	"	"	"	"
B3	"	"	"	"	"	"
B4	"	"	"	"	"	"
B5	"	"	"	"	"	"
B6	"	"	"	"	"	"
B7	"	"	"	"	"	"
B8	"	"	"	"	"	"
B9	"	"	"	"	"	"
BA	"	"	"	"	"	"
BB	"	"	"	"	"	"
BC	"	"	"	"	"	"
BD	"	"	"	"	"	"
BE	"	"	"	"	"	"
BF	"	"	"	"	"	"
C0	"	"	"	"	"	"
C1	"	"	"	"	"	"
C2	"	"	"	"	"	"
C3	"	"	"	"	"	"
C4	"	"	"	"	"	"
C5	"	"	"	"	"	"
C6	"	"	"	"	"	"
C7	"	"	"	"	"	"
C8	"	"	"	"	"	"
C9	"	"	"	"	"	"
CA	"	"	"	"	"	"
CB	"	"	"	"	"	"
CC	"	"	"	"	"	"
CD	"	"	"	"	"	"
CE	"	"	"	"	"	"
CF	"	"	"	"	"	"
D0	"	"	"	"	"	"
D1	"	"	"	"	"	"
D2	"	"	"	"	"	"
D3	"	"	"	"	"	"
D4	"	"	"	"	"	"
D5	"	"	"	"	"	"
D6	"	"	"	"	"	"
D7	"	"	"	"	"	"
D8	"	"	"	"	"	"
D9	"	"	"	"	"	"
DA	"	"	"	"	"	"
DB	"	"	"	"	"	"
DC	"	"	"	"	"	"
DD	"	"	"	"	"	"
DE	"	"	"	"	"	"
DF	"	"	"	"	"	"
E0	"	"	"	"	"	"
E1	"	"	"	"	"	"
E2	"	"	"	"	"	"
E3	"	"	"	"	"	"
E4	"	"	"	"	"	"
E5	"	"	"	"	"	"
E6	"	"	"	"	"	"
E7	"	"	"	"	"	"
E8	"	"	"	"	"	"
E9	"	"	"	"	"	"
EA	"	"	"	"	"	"
EB	"	"	"	"	"	"
EC	"	"	"	"	"	"
ED	"	"	"	"	"	"
EE	"	"	"	"	"	"
EF	"	"	"	"	"	"
F0	"	"	"	"	"	"
F1	"	"	"	"	"	"
F2	"	"	"	"	"	"
F3	"	"	"	"	"	"
F4	"	"	"	"	"	"
F5	"	"	"	"	"	"
F6	"	"	"	"	"	"
F7	"	"	"	"	"	"
F8	"	"	"	"	"	"
F9	"	"	"	"	"	"
FA	"	"	"	"	"	"
FB	"	"	"	"	"	"
FC	"	"	"	"	"	"
FD	"	"	"	"	"	"
FE	"	"	"	"	"	"
FF	"	"	"	"	"	"

HEX	ASCII		EBCDIC		ASCII	EBCDIC
	UPPER	LOWER	UPPER	LOWER		
00	Blank	Blank	"	"	"	"
01	"	"	"	"	"	"
02	LF	LF	"	"	"	"
03	"	"	"	"	"	"
04	Space	Space	"	"	"	"
05	"	"	"	"	"	"
06	"	"	"	"	"	"
07	"	"	"	"	"	"
08	"	"	"	"	"	"
09	"	"	"	"	"	"
0A	"	"	"	"	"	"
0B	"	"	"	"	"	"
0C	"	"	"	"	"	"
0D	"	"	"	"	"	"
0E	"	"	"	"	"	"
0F	"	"	"	"	"	"
10	"	"	"	"	"	"
11	"	"	"	"	"	"
12	"	"	"	"	"	"
13	"	"	"	"	"	"
14	"	"	"	"	"	"
15	"	"	"	"	"	"
16	"	"	"	"	"	"
17	"	"	"	"	"	"
18	"	"	"	"	"	"
19	"	"	"	"	"	"
1A	"	"	"	"	"	"
1B	"	"	"	"	"	"
1C	"	"	"	"	"	"
1D	"	"	"	"	"	"
1E	"	"	"	"	"	"
1F	"	"	"	"	"	"
20	"	"	"	"	"	"
21	"	"	"	"	"	"
22	"	"	"	"	"	"
23	"	"	"	"	"	"
24	"	"	"	"	"	"
25	"	"	"	"	"	"
26	"	"	"	"	"	"
27	"	"	"	"	"	"
28	"	"	"	"	"	"
29	"	"	"	"	"	"
2A	"	"	"	"	"	"
2B	"	"	"	"	"	"
2C	"	"	"	"	"	"
2D	"	"	"	"	"	"
2E	"	"	"	"	"	"
2F	"	"	"	"	"	"
30	"	"	"	"	"	"
31	"	"	"	"	"	"
32	"	"	"	"	"	"
33	"	"	"	"	"	"
34	"	"	"	"	"	"
35	"	"	"	"	"	"
36	"	"	"	"	"	"
37	"	"	"	"	"	"
38	"	"	"	"	"	"
39	"	"	"	"	"	"
3A	"	"	"	"	"	"
3B	"	"	"	"	"	"
3C	"	"	"	"	"	"
3D	"	"	"	"	"	"
3E	"	"	"	"	"	"
3F	"	"	"	"	"	"
40	"	"	"	"	"	"
41	"	"	"	"	"	"
42	"	"	"	"	"	"
43	"	"	"	"	"	"
44	"	"	"	"	"	"
45	"	"	"	"	"	"
46	"	"	"	"	"	"
47	"	"	"	"	"	"
48	"	"	"	"	"	"
49	"	"	"	"	"	"
4A	"	"	"	"	"	"
4B	"	"	"	"	"	"
4C	"	"	"	"	"	"
4D	"	"	"	"	"	"
4E	"	"	"	"	"	"
4F	"	"	"	"	"	"
50	"	"	"	"	"	"
51	"	"	"	"	"	"
52	"	"	"	"	"	"
53	"	"	"	"	"	"
54	"	"	"	"	"	"
55	"	"	"	"	"	"
56	"	"	"	"	"	"
57	"	"	"	"	"	"
58	"	"	"	"	"	"
59	"	"	"	"	"	"
5A	"	"	"	"	"	"
5B	"	"	"	"	"	"
5C	"	"	"	"	"	"
5D	"	"	"	"	"	"
5E	"	"	"	"	"	"
5F	"	"	"	"	"	"
60	"	"	"	"	"	"
61	"	"	"	"	"	"
62	"	"	"	"	"	"
63	"	"	"	"	"	"
64	"	"	"	"	"	"
65	"	"	"	"	"	"
66	"	"	"	"	"	"
67	"	"	"	"	"	"
68	"	"	"	"	"	"
69	"	"	"	"	"	"
6A	"	"	"	"	"	"
6B	"	"	"	"	"	"
6C	"	"	"	"	"	"
6D	"	"	"	"	"	"
6E	"	"	"	"	"	"
6F	"	"	"	"	"	"
70	"	"	"	"	"	"
71	"	"	"	"	"	"
72	"	"	"	"	"	"
73	"	"	"	"	"	"
74	"	"	"	"	"	"
75	"	"	"	"	"	"
76	"	"	"	"	"	"
77	"	"	"	"	"	"
78	"	"	"	"	"	"
79	"	"	"	"	"	"
7A	"	"	"	"	"	"
7B	"	"	"	"	"	"
7C	"	"	"	"	"	"
7D	"	"	"	"	"	"
7E	"	"	"	"	"	"
7F	"	"	"	"	"	"
80	"	"	"	"	"	"
81	"	"	"	"	"	"
82	"	"	"	"	"	"
83	"	"	"	"	"	"
84	"	"	"	"	"	"
85	"	"	"	"	"	"
86	"	"	"	"	"	"
87	"	"	"	"	"	"
88	"	"	"	"	"	"
89	"	"	"	"	"	"
8A	"	"	"	"	"	"
8B	"	"	"	"	"	"
8C	"	"	"	"	"	"
8D	"	"	"	"	"	"
8E	"	"	"	"	"	"
8F	"	"	"	"	"	"
90	"	"	"	"	"	"
91	"	"	"	"	"	"
92	"	"	"	"	"	"
93	"	"	"	"	"	"
94	"	"	"	"	"	"
95	"	"	"	"	"	"
96	"	"	"	"	"	"
97	"	"	"	"	"	"
98	"	"	"	"	"	"
99	"	"	"	"	"	"
9A	"	"	"	"	"	"
9B	"	"	"	"	"	"
9C	"	"	"	"	"	"
9D	"	"	"	"	"	"
9E	"	"	"	"	"	"
9F	"	"	"	"	"	"
A0	"	"	"	"	"	"
A1	"	"	"	"	"	"
A2	"	"	"	"	"	"
A3	"	"	"	"	"	"
A4	"	"	"	"	"	"
A5	"	"	"	"	"	"
A6	"	"	"	"	"	"
A7	"	"	"	"	"	"
A8	"	"	"	"	"	"
A9	"	"	"	"	"	"
AA	"	"	"	"	"	"
AB	"	"	"	"	"	"
AC	"	"	"	"	"	"
AD	"	"	"	"	"	"
AE	"	"	"	"	"	"
AF	"	"	"	"	"	"
B0	"	"	"	"	"	"
B1	"	"	"	"	"	"
B2	"	"	"	"	"	"
B3	"	"	"	"	"	"
B4	"	"	"	"	"	"
B5	"	"	"	"	"	"
B6	"	"	"	"	"	"
B7	"	"	"	"	"	"
B8	"	"	"	"	"	"
B9	"	"	"	"	"	"
BA	"	"	"	"	"	"
BB	"	"	"	"	"	"
BC	"	"	"	"	"	"
BD	"	"	"	"	"	"
BE	"	"	"	"	"	"
BF	"	"	"	"	"	"
C0	"	"	"	"	"	"
C1	"	"	"	"	"	"
C2	"	"	"	"	"	"
C3	"	"	"	"	"	"
C4	"	"	"	"	"	"
C5	"	"	"	"	"	"
C6	"	"	"	"	"	"
C7	"	"	"	"	"	"
C8	"	"	"	"	"	"
C9	"	"	"	"	"	"
CA	"	"	"	"	"	"
CB	"	"	"	"	"	"
CC	"	"	"	"	"	"
CD	"	"	"	"	"	"
CE	"	"	"	"	"	"
CF	"	"	"	"	"	"
D0	"	"	"	"	"	"
D1	"	"	"	"	"	"
D2	"	"	"	"	"	"
D3	"	"	"	"	"	"
D4	"	"	"	"	"	"
D5	"	"	"	"	"	"
D6	"	"	"	"	"	"
D7	"	"	"	"	"	"
D8	"	"	"	"	"	"
D9	"	"	"	"	"	"
DA	"	"	"	"	"	"
DB	"	"	"	"	"	"
DC	"	"	"	"	"	"
DD	"	"	"	"	"	"
DE	"	"	"	"	"	"
DF	"	"	"	"	"	"
E0	"	"	"	"	"	"
E1	"	"	"	"	"	"
E2	"	"	"	"	"	"
E3	"	"	"	"	"	"
E4	"	"	"	"	"	"
E5	"	"	"	"	"	"
E6	"	"	"	"	"	"
E7	"	"	"	"	"	"
E8	"	"	"	"	"	"
E9	"	"	"	"	"	"
EA	"	"	"	"	"	"
EB	"	"	"	"	"	"
EC	"	"	"	"	"	"
ED	"	"	"	"	"	"
EE	"	"	"	"	"	"
EF	"	"	"	"	"	"
F0	"	"	"	"	"	"
F1	"	"	"	"	"	"
F2	"	"	"	"	"	"
F3	"	"	"	"	"	"
F4	"	"	"	"	"	"
F5	"	"	"	"	"	"
F6	"	"	"	"	"	"
F7	"	"	"	"	"	"
F8	"	"	"	"	"	"
F9	"	"	"	"	"	"
FA	"	"	"	"	"	"
FB	"	"	"	"	"	"
FC	"	"	"	"	"	"
FD	"	"	"	"	"	"
FE	"	"	"	"	"	"
FF	"	"	"	"	"	"

APPENDIX C

TREND 1-9-1 MESSAGES

Auxiliary Function 65 (see Section 4.6.5.4) allows the user to automatically place four standard Trend 1-9-1 asynchronous messages into the DATA SENTRY 10 USER 1, USER 2, USER 3, and USER 4 messages. These messages are described below, and the recommended code level, parity and preamble selections (these are not under control of Auxiliary Function 65) are given for each message.

USER 1

Pattern: "Q9S" per CCITT Recommendation R.51

Code: Baudot Code Level: 5

Parity: None Preamble: 09

Hex:	1F	05	08	02	17	1B	04	18
Message:	LTRS	S	CR	LF	Q	FIGS	SP	9

USER 2

Pattern: FOX message

Code: Baudot Code Level: 5

Parity: None Preamble: 09

Hex:	02	08	02	08	1F	10	14	01	04	17	07	06
Message:	LF	CR	LF	CR	LTRS	T	H	E	SP	Q	U	I

Hex: 0E 0F 04 19 0A 18 13 0C 04 0D 18 1D
 Message: C K SP B R O W N SP F O X

Hex: 04 0B 07 1C 16 05 04 18 1E 01 0A 04
 Message: SP J U M P S SP O V E R SP

Hex: 10 14 01 04 12 03 11 15 04 09 18 1A
 Message: T H E SP L A Z Y SP D O G

Hex: 04 1B 17 13 01 0A 10 15 07 06 18 16
 Message: SP FIGS 1 2 3 4 5 6 7 8 9 0

USER 3

Pattern: FOX message

Code: ASCII

Code Level: 7

Parity: Even

Preamble: 16

Hex: 0A 0D 0A 0D 54 48 45 20 51 55 49 43
 Message: LF CR LF CR T H E SP Q U I C

Hex: 4B 20 42 52 4F 57 4E 20 46 4F 58 20
 Message: K SP B R O W N SP F O X SP

Hex: 4A 55 4D 50 53 20 4F 56 45 52 20 54
 Message: J U M P S SP O V E R SP T

Hex: 48 45 20 4C 41 5A 59 20 44 4F 47 20
 Message: H E SP L A Z Y SP D O G SP

Hex: 31 32 33 34 35 36 37 38 39 30
 Message: 1 2 3 4 5 6 7 8 9 0

USER 4

Pattern: FOX message

Code: EBCDIC

Code Level: 8

Parity: None

Preamble: 32

Hex:	25	0D	25	0D	E3	C8	C5	40	D8	E4	C9	C3
Message:	LF	CR	LF	CR	T	H	E	SP	Q	U	I	C

Hex:	D2	40	C2	D9	D6	E6	D5	40	C6	D6	E7	40
Message:	K	SP	B	R	O	W	N	SP	F	O	X	SP

Hex:	D1	E4	D4	D7	E2	40	D6	E5	C5	D9	40	E3
Message:	J	U	M	P	S	SP	O	V	E	R	SP	T

Hex:	C8	C5	40	D3	C1	E9	E8	40	C4	D6	C7	40
Message:	H	E	SP	L	A	Z	Y	SP	D	O	G	SP

Hex:	F1	F2	F3	F4	F5	F6	F7	F8	F9	F0
Message:	1	2	3	4	5	6	7	8	9	0

THE
GET
BACK
TO
BASIC

35400

DESIGNED BY ASONI, INC.
ALBANY, MA 01702
MADE IN U.S.A.

